DRAFT FINAL

Remedial Investigation Report for the Former ARMCO Hamilton Plant Site

401 Augspurger Road, New Miami, Ohio

VOLUME 1 OF 10

Prepared for:

AKSteel
AK Steel Corporation
9227 Centre Pointe Drive
West Chester, OH 45069

Prepared by:

KEMRON
ENVIRONMENTAL SERVICES
KEMRON Environmental Services, Inc.
156 Starlite Drive
Marietta, OH 43756

November 2008

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KEMRON
ENVIRONMENTAL SERVICES

156 Starlite Drive ▪ Marietta, OH 45750 ▪ TEL (740) 373-4308 ▪ FAX (740) 376-2536 ▪ http://www.kemron.com

November 25, 2008

Mr. Pablo Valentin
Remedial Project Manager
US EPA, Region 5
Superfund Division, RRB1/RRS3
77 West Jackson Blvd.
Chicago, IL 60604

RE: Submittal of Revised Baseline Human Health Risk Assessment, Baseline Ecological Risk Assessment, and Draft Final Remedial Investigation Report, Former ARMCO Hamilton Plant, New Miami, Ohio

Dear Mr. Valentin:

On behalf of AK Steel Corporation, KEMRON Environmental Services, Inc., (KEMRON) is pleased to submit the enclosed *Revised Baseline Human Health Risk Assessment*, *Baseline Ecological Risk Assessment*, and *Draft Final Remedial Investigation Report* for the Former ARMCO Hamilton Plant Site. As requested by USEPA, two copies of each report are enclosed.

The Baseline Human Health Risk Assessment has been revised to address USEPA 2007 and 2008 comments, as well as to include new environmental data acquired in 2008. The Baseline Ecological Risk Assessment has been prepared to address the ecological risk assessment requirements as agreed upon via the Final Screening Level Ecological Risk Assessment for the Site and the Draft Final Risk Assessment Assumptions Document.

The revised Remedial Investigation (RI) Report incorporates the Site environmental data collected throughout the Remedial Investigation, including data acquired by ENSR and by KEMRON. The findings of both risk assessments are incorporated into the RI Report, and specific recommendations are made. The RI has been conducted and the documents have been prepared in accordance with the Administrative Order on Consent (Order, EPA Docket No. V-W-'02-C-692), applicable requirements of CERLCA and the NCP, and relevant USEPA and Ohio EPA guidance and policy.

The RI Report fully addresses the RI objectives specified in the Order:

- To evaluate the nature and extent of hazardous substances or contaminants, if any, at and from the former ARMCO Hamilton Plant property and off-property areas where hazardous substances or contaminants, if any, at and from the property have or may have come to be located (the "Site"); and,
- Assess the risk from these hazardous substances or contaminants, if any, on human health and the environment.

As specified in the project schedules agreed to by USEPA and Ohio EPA, we respectfully request that you complete your review and provide comments on the enclosed documents within forty-five days, or by January 27, 2009. As we have discussed in project conference calls, KEMRON is available to discuss any interim questions or clarifications with the reviewers. Further, it is anticipated that preliminary comments will be provided informally prior to the January 14, 2009 project meeting scheduled to be held in West Chester, Ohio, to allow KEMRON and AK Steel to provide initial responses.

Please feel free to contact me at (740) 373-1266 or at mrochotte@kemron.com if you have any questions.

Sincerely,
KEMRON Environmental Services, Inc.

Mary Lou Rochotte

Mary Lou Rochotte
Senior Project Manager

Enclosures

cc w/enclosure:	Dave Miracle, AK Steel Corporation Nita Nordstrom, OEPA, DERR, SWDO Dave Franc, Tetra Tech EMI Wendy Coates, AK Steel Asset Management
cc w/o enclosure:	Carl Batliner, AK Steel Corporation

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Acronyms / Abbreviations

AOC	Area of concern
AST	Aboveground storage tank
ASTM	American Society for Testing and Materials
BERA	Baseline Ecological Risk Assessment
bgs	Below ground surface
BTEX	Benzene, toluene, ethylbenzene, xylenes
BUSTR	Bureau of Underground Storage Tank Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COG	Coke oven gas
COPC	Contaminant of potential concern
CSM	Conceptual site model
DAF	Dilution Attenuation Factor
DOE	United States Department of Energy
DQO	Data quality objective
ENSR	ENSR Corporation
ERA	Ecological Risk Assessment
ESL	Ecological Screening Level
FOC	Fraction of organic carbon
FSP	Field Sampling Plan
ft	Feet
GMR	Great Miami River
GPS	Global Positioning System
HASP	Health and Safety Plan
HCP	Hamilton Coke Plant
HHRA	Human Health Risk Assessment
HSA	Hollow stem auger
KEMRON	KEMRON Environmental Services, Inc.
mg/Kg	Milligrams per kilogram
mg/L	Milligrams per liter
µg/L	Micrograms per liter
µg/Kg	Micrograms per kilogram
NCDC	National Climatic Data Center
NCP	National Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
OEPA	Ohio Environmental Protection Agency
Order	Administrative Order on Consent
OSHA	Occupational Safety and Health Administration
PAH	Polyaromatic hydrocarbon
PCB	Polychlorinated biphenyl
PFS	Problem Formulation Statement
PID	Photoionization detector
ppb	Parts per billion
PRG	Preliminary remediation goal
PVC	Polyvinyl chloride
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance / Quality Control

RAAD	Risk Assessment Assumptions Document
RI/FS	Remedial Investigation / Feasibility Study
SLERA	Screening Level Ecological Risk Assessment
SOP	Standard Operating Procedure
SOW	Statement of Work
SPLP	Synthetic Precipitation Leaching Procedure
SSL	Soil Screening Level
SSP	Support Sampling Plan
SWP	Supplemental Remedial Investigation Work Plan
SVOC	Semi-volatile organic compound
TAL	Target analyte list
TCL	Target compound list
US EPA	United States Environmental Protection Agency
USCS	Unified Soil Classification System
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UST	Underground storage tank
VOC	Volatile organic compounds
VF	Volatilization factor
VSP	Visual Sampling Plan

1.0 Introduction

On April 29, 2002, the United States Environmental Protection Agency (U.S. EPA) and AK Steel Corporation (AK Steel) entered into an Administrative Order on Consent (Order; EPA Docket No. V-W-'02-C-692) pursuant to the Comprehensive, Environmental Response, Compensation and Liability Act of 1980 (CERCLA) for a Remedial Investigation/Feasibility Study (RI/FS) at the former ARMCO Hamilton Plant (AHP) facility (the Site) located at 401 Augspurger Road in New Miami, Ohio. AK Steel submitted the required Quality Management Plan (QMP) to U.S. EPA on May 28, 2002, for approval. The QMP identified ENSR Corporation (ENSR) as the Supervising Contractor to manage the RI/FS activities at the Site.

In August 2005, the *RI/FS Study Support Sampling Plan* (Revision 3) was submitted for the Former Armco Hamilton Plant Site, 401 Augspurger Road, New Miami, Butler County, Ohio. The RI/FS Support Sampling Plan (SSP) described the activities, methods and procedures proposed to accomplish the objectives of the RI/FS. The SSP summarized existing reports and data, described sampling objectives and additional data required, described sampling procedures and data quality objectives, and provided the Quality Assurance Project Plan (QAPP), Health and Safety Plan (HSP), and project schedule for the RI/FS at the Site.

The objectives of the RI/FS are as follows:

- To determine the nature and extent of contamination and threat to the public health, welfare, or the environment, if any, caused by the release or threatened release of hazardous substances, pollutants, or contaminants at or from the Site, by conducting a remedial investigation, which includes human health and ecological risk assessment;
- To evaluate the nature and extent of hazardous substances, if any, at and from the AHP property and off-property areas where hazardous substances, if any, from the property have or may have come to be located, and also assess the risk from these hazardous substances (if any) on human health and the environment;
- To determine and evaluate alternatives for remedial action (if any) to prevent, mitigate, or otherwise respond to or remedy releases or threatened release of hazardous substances, pollutants, or contaminants at or from the Site or facility, by conducting a feasibility study; and
- To evaluate alternatives for addressing the impact (if any) to human health and the environment from hazardous substances at the Site.

Field activities for this project included investigation of site physical characteristics, characterization of potential source areas, and evaluation of the extent and nature of hazardous substances. The study included evaluation of local and regional hydrogeology and groundwater, sediments and surface and subsurface soils, potential impacts to surface water, potential air hazards, and potential impacts on ecology. Samples were collected both on site and off-site for the purposes of delineation, determination of local background concentrations of contaminants and to determine the impacts of off-site sources such as the Coke-Oven Gas Pipeline (COG).

In April 2008, AK Steel notified US EPA that KEMRON Environmental Services, Inc. (KEMRON) had assumed the role of Supervising Contractor to manage continuing RI/FS activities at the Site. AK Steel and KEMRON met with US EPA and OEPA on April 14, 2008 at the USEPA Region 5 offices to introduce the new Supervising Contractor key personnel, and to review the project status and plan for completing the RI. A subsequent meeting was conducted on April 28, 2008, at

AK Steel Corporate Offices in West Chester, Ohio, to review and finalize the scope of work for a Supplemental Remedial Investigation Work Plan. In May 2008, KEMRON finalized the Supplemental Remedial Investigation Work Plan (SWP), and submitted addenda to the project QAPP and HSP. USEPA and OEPA subsequently approved the SWP, and revised QAPP and HASP.

This RI Report is based upon and includes findings of the entire scope of work completed at the Site by both ENSR and KEMRON on behalf of AK Steel Corporation. This Report considers and utilizes the full set of analytical data from the ENSR 2006 Draft RI as well as that generated through KEMRON's implementation of the Supplemental Remedial Investigation Work Plan in 2008.

1.1 Purpose of report

The purpose of this Remedial Investigation Report is to summarize and present the results of the remedial investigation activities performed at the Site. The remedial investigation activities were conducted to sufficiently characterize the site conditions, the sources of contamination, the nature and extent of contamination and its associated impacts in order to adequately identify the risk to human health and the environment. The investigation activities have been conducted and the report prepared in accordance with CERCLA, the National Contingency Plan (NCP), US EPA guidance relevant to conducting RI/FS (including but not limited to USEPA, 1989a; USEPA, 1990; and guidance referenced therein), guidance referenced in the SOW as may be amended or modified by US EPA, and the RI/FS SSP (ENSR, 2005; KEMRON Addendum, 2008).

1.2 Site background

1.2.1 Site description

As defined in the Order and Statement of Work (SOW) incorporated in the Order, the Site includes the property located at 401 Augspurger Road, Butler County, Ohio, which is approximately 252 acres divided between two parcels of land immediately adjacent and to the north of Augspurger Road (northern parcel) and immediately adjacent and to the south of Augspurger Road (southern parcel). Based on review of previous reports, site reconnaissance, and interviews, the Site was divided into potential areas of concern (AOCs) and former production and slag processing areas (Block Areas) to facilitate the investigation and characterization of potential sources of hazardous substances. The northern and southern parcels (including the AOCs and Block Areas contained within each parcel) are described in further detail below. The AOCs and Block Areas are numbered and lettered for referencing convenience only. (Figure 1.2.1-1 Site Locus Map)

Southern parcel

The southern parcel is bordered by the Great Miami River, to the west by a rail yard operated by CSX Transportation and to the north by Augspurger Road. The southern parcel is located in Sections 21 and 22 in St. Clair Township, Butler County, Ohio, and is within the township limits of New Miami, Ohio. The southern parcel, now vacant, formerly contained the Hamilton Coke Plant (HCP), two blast furnaces for ore making, a sinter plant, and associated coal handling facilities. Very little evidence remains of the HCP and the blast furnace area, which were decommissioned/demolished in 1988-89 and 1993-95, respectively. The roadway through the property remains, and a large hilly area exists on the western side of the property where the blast furnaces were located. Some concrete slabs remain, indicating where buildings and a large gas collector were located. The majority of the Site is covered with tall grass and occasional trees.

This parcel is surrounded by a chain-link fence and remains locked. The Site is routinely patrolled by AK Steel personnel to ensure the southern parcel remains secure.

At the northern portion of the southern parcel, fuel oil aboveground storage tanks (ASTs) and thaw pits were used to heat the undercarriage of the railcars during inclement weather (**AOC 8** – Former Railcar Thaw Area). Along the eastern portion of the southern parcel, various sumps, pits and pipelines were located in the former by-products area (**AOC 13** – Former By-Products Area). Within AOC 13, a gasoline underground storage tank (UST) of unknown size (**AOC 11** – Former Gasoline UST) was believed to be present south of the coke by-products area and was apparently used to refuel vehicles during pre- and post-WWII. To the north and south of AOC 13 were former operational transformers and compressors (**AOC 14** and **AOC 15** – Former Transformers / Compressors), which were PCB-contaminated prior to a change in use of dielectric fluids. To the northwest of AOC 13 are **Block D** (Former Railroad Repair Area), **Block E** (Former Quenching Station Area), and **Block G** (Former Coal Handling / Coke Battery Production Area). **Block F** (Former Met Screening Station Area) is located further to the northwest of Block G.

At the far southern end of the parcel, two ASTs (**AOC 10** – Former Fuel Oil Aboveground Storage Tanks) provided backup fuel to the boiler house and were located southwest of the former spray pond, which is contained within **Block B** – Former Sinter Production Area. Two settling ponds (**AOC 12** – Former Wastewater Settling Ponds) were installed in the 1930s to handle contact wastewater from the blast furnace flue gas. These ponds were closed in 1995. Two USTs were located immediately northeast of the former spray pond (**AOC 9** – Former Fuel Oil USTs). No. 6 fuel oil was staged in these 500- and 1,000-gallon tanks. **Block C** (Former Blast Furnaces Production Area) is located to the north of AOC 9.

Four former stormwater outfalls are located along the banks of the Great Miami River along the southern parcel (**AOC 3, AOC 4, AOC 5, and AOC 6** – Former Stormwater Outfalls). These outfalls collected stormwater from the coke plant and blast furnace areas. The remaining areas between the AOCs and Block Areas identified within the southern parcel (**AOC 20** – Remaining Areas on Southern Parcel) were occupied by miscellaneous yard storage (railroad tracks, ore storage, miscellaneous buildings and operations), wooded areas, parking, administration, buildings, and roads.

Following completion of the initial RI work at the site, it was determined that the Great Miami River riparian area should be investigated as part of a Supplemental RI work effort. The riparian area was designated as **AOC 22**.

Northern parcel

The northern parcel is located north of Augspurger Road and is bounded to the west-northwest by a rail yard operated by CSX Transportation, to the northeast by Jackson Road, to the east-southeast by residential property, and to the south by Augspurger Road and the Great Miami River. This northern parcel lies within Section 15 in St. Clair Township, Butler County, Ohio. A CSX rail line bisects this parcel, east to west, parallel to Augspurger Road. The portion of the parcel between Augspurger Road and the CSX rail line was used to store coal for the HCP and later for storing air scrubber sludge and dust from the blast furnaces (**AOC 1** – Former Air Scrubber Sludge Storage and Railyard Area). A slag processing plant was located on the northwestern portion of the north parcel (**Block A** – Former Slag Processing Area). No buildings are present at the location of the former slag plant; however, concrete block walls remain in one area and a large demolished concrete structure remains in another area.

A closed landfill is located on the east side of this northern parcel north of the east-west rail line (**AOC 2** – Closed Landfill) which was utilized for the disposal of tar decanter sludge and general facility trash. The closed landfill is bounded to the north and west by slag piles, abandoned rail lines and a partially wooded area; to the east by a wooded area containing a swale/drainage ditch (**AOC 7** – Drainage Ditch); and to the south by the east-west CSX rail line. The closed landfill is approximately 4-5 acres in size, has approximately 3-5 feet of topographic relief and is covered with tall grass. The closed landfill remains completely surrounded by a chain-link fence and has locked gates and "No Trespassing" signs posted to prevent unauthorized access. The CSX rail line crosses over the ditch in AOC 7 and a number of old rail ties are located immediately adjacent to the railroad tracks. The remaining portions of the northern parcel (**AOC 21** – Remaining Areas on Northern Parcel) consist of wooded areas to the north and east of Block A. The portion of the northern parcel along Augspurger Road is unfenced. The areas of the site to the North and West are fenced along the boundaries with residential areas. Access to the site north of the east-west railroad is restricted since the only road allowing access to the part of the site is controlled by a locked gate. No Trespassing signs which identify the property as an AK Steel parcel are posted along the northern parcel property boundaries facing Augspurger Road. The Site is routinely patrolled by AK Steel personnel.

Former COG pipeline and off-site concerns

Subgrade pipelines remaining on the Site include the following:

- a Cincinnati Gas and Electric Company (CG&E) pipeline on the east side of the southern parcel was used to supply natural gas to the blast furnace area;
- a decommissioned predominantly 16-inch diameter underground coke oven gas (COG) pipeline located on the eastern portion of the southern parcel and the western portion of the northern parcel (**AOC 18** – Former Coke Oven Gas Pipeline Onsite) and located offsite between the Site and the AK Steel Middletown Works (**AOC 19** – Former Coke Oven Gas Pipeline Offsite); and,
- various decommissioned underground process lines and sewer lines on the southern parcel associated with past plant operations.

AOC 16 (Offsite Concerns for the Southern Parcel) includes the western boundary of the southern parcel where impacted from both historic and current adjoining properties (i.e., The Former Otto Coke Company/New Miami Maintenance Department) that potentially could affect the environmental condition of the Site. **AOC 17** (Offsite Concerns for the Northern Parcel) includes the western boundary of the northern parcel where impact from adjoining properties, specifically CSX, could affect the environmental condition of the Site.

1.2.2 Site history

Prior to development of the Site, a coke plant (The Former Otto Coke Company) existed immediately west of (and adjacent to) the western property boundary of the southern parcel of the Site. The Former Otto Coke plant operated until 1913.

The southern parcel of the Site was initially developed in July 1907 as the Hamilton Iron and Steel Company which built a blast furnace plant on the property. The plant operated periodically until closure in 1912. The Koppers Company of Pittsburgh, Pennsylvania, purchased the plant in 1927 and renamed the plant the Hamilton Coke & Iron Company. At that time, 45 Becker-type coke ovens were erected, along with ancillary coke by-product equipment to recover tar, light oil, naphthalene, phenol, and ammonia sulfate from coke making operations. A COG gas holder (approximately five million cubic feet capacity) was also constructed and operated by CG&E. In

1932, a new boiler plant was built for the blast furnace area. The boilers used blast furnace gas as a primary fuel and No. 6 fuel oil and coal/coke as backup fuel. A second blast furnace was constructed on the southern parcel by Koppers in 1937.

Three water wells (installed in the sand and gravel unit at approximately 200 ft bgs) were drilled and installed in 1927 for blast furnace cooling purposes, each having a capacity of 2,400 gallons per minute. These wells were abandoned by 1948. Five additional wells were drilled and installed (between 1927 and 1956), having a total source capacity of 8,000 gallons per minute. The American Rolling Mill Company (Armco) purchased the plant from Koppers in 1937. Koppers maintained a leased portion of the plant area (adjacent to the benzol yard) for the manufacturing of road tar.

Two settling ponds were installed in the 1930s to handle scrubber wastewater from the blast furnace flue gas. Sludge was periodically dredged from the two settling ponds and stored in piles in the railyard area on the northern parcel (north of Augspurger Road). This "scrubber" sludge was reused in Armco's iron production due to its high iron content. Armco also sold some of the scrubber sludge to other steel companies. Armco estimated that as much as 180,000 cubic yards might have been stored at the site. Between 1989 and 1990, the remaining approximate 18,000 cubic yards of scrubber sludge were transported to Armco's Sinter Plant in Middletown, Ohio. Use of the settling ponds was discontinued in 1990, upon shutdown of the last blast furnace. The ponds were cleaned out in 1993 and permanently closed in 1995 by filling in the drained ponds with onsite fill material.

During the 1950s and 1960s, a small disposal area was also reportedly located between the settling ponds and the southern fence line. The approximate area is included in investigation areas AOC 20 and AOC 10.

A major plant upgrade program took place in 1977 and 1978, which included the installation of state-of-the-art water pollution control facilities to treat ammonia still waste, benzol plant waste, quench tower waste, and non-contact cooling water at the coke plant. In addition, the phenol recovery process was removed and replaced with a biological wastewater treatment plant.

In 1979-1980, a No. 6 fuel oil spill reportedly occurred when an ore bridge was blown over by a heavy wind and severed the fuel line to the boilers. The approximate area of the reported spill is included in investigation areas AOC 20, AOC 9, AOC 10 and Block B.

Coke plant operations ceased in 1982. At the time of closure, coke making occurred in four batteries with a total of 110 ovens. In 1982, coke production stood at approximately 1,600 tons per day. All blast furnace activities ceased in 1990. The No. 2 blast furnace was shut down in 1986 and the No. 1 blast furnace in 1990. Prior to closure, each furnace was producing approximately 1,000 tons of iron per day.

In 1994, Armco Steel L.P. conveyed title to the Site to AK Steel Corporation.

At the time of total plant closure, 14 water wells existed on the property, which included one well used by the Miami Conservancy District for monitoring purposes. All wells were installed within the sand and gravel aquifer to approximately 200 ft bgs and properly abandoned upon plant closure. The approximate locations of former production wells on the Site are shown on Figures 7, 8, and 9 of the SSP (ENSR 2005).

At the height of operation, the plant facility had four outfalls (i.e., 001, 002, 003, and 004).

- Outfall 001 drained stormwater from the southern end of the parcel. In addition, treated overflow from the settling ponds and non-contact cooling water from the cooling tower drained though this NPDES outfall.
- Outfall 002 drained the southeast part of the southern parcel and also contained boiler blowdown, non-contact cooling water, and treated sanitary discharge.
- Outfall 003 was used primarily for stormwater drainage from the production areas in the southern portion of the site.
- Outfall 004 drained stormwater from the area around the by-products building.

OH Materials Corporation (OHM) was contracted in 1988-89 to perform insulation removal, decontamination, and demolition of the coke plant facility. From 1993-1995, the blast furnaces and all other buildings and structures at the Site were decommissioned and demolished. No manufacturing has occurred on the Site since that time, and no aboveground structures remain on the Site.

The southern half of the northern parcel (i.e., south of the east-west rail line) was initially used to store raw material (coal) for the coking operations. As discussed above, air scrubber sludge was periodically dredged from the two settling ponds associated with the blast furnaces on the southern parcel and stored in piles in this area, beginning in the 1980s.

The western portion of the northern parcel (an area covering approximately 38 acres) was leased to American Materials Corporation for operation of a slag plant – slag being a by-product material of the iron production operations on the southern parcel. The slag material was sized and sold.

In addition, a landfill, approximately 4-5 acres in size, was active on the northern parcel from the early 1960s to 1980, for the disposal of tar decanter sludge (a by-product of the coking operations). Slag, rubble, and general trash were also disposed in the landfill. Little information exists regarding the depth of burial and waste disposal practices.

Landfill closure was completed in October 1980 in accordance with the necessary provisions of Ohio EPA's then-existing solid waste landfill closure rules, OAC Rule 3745-27-10 titled "Closure of Sanitary Landfill." At closure, the material in the landfill was stabilized with slag, graded to slopes greater than 1% and less than 25% to facilitate surface water runoff and drainage, covered with two feet of compacted low permeability clay, then with topsoil, and then seeded with grass to complete a dense cover. The landfill remains completely surrounded by a chain-link fence, has locked gates and "No Trespassing" signs posted to prevent unauthorized access.

Historical site features and areas of investigation are shown on Figure 1.2.2-1. The off-site Former COG pipeline is shown on Figure 1.2.2-2.

1.2.3 Permit history

Available records are limited regarding previous permit information for the former Armco Hamilton Plant. Prior to initiating the initial RI field activities, two sets of records from AK Steel's files were reviewed: one set related to the potable well located onsite and the other set from a National Pollutant Discharge Elimination System (NPDES) permit. During the RI field activities, file reviews were performed at the Hamilton County Department of Environmental Services (for facility air permits) and at the Ohio EPA Central office (for facility water and waste permits). Detailed information from the sets of files is described below.

Potable Well File

On February 25, 1988, Ohio EPA issued a letter indicating that the drinking water well (PWSID #0937612) supplying 25 or more people for at least 60 days out of the year made the well a non-community public water supply.

A May 30, 1989, letter from Ohio EPA states that the facility water system was in violation of federal regulations requiring public notices regarding lead in drinking water for non-transient, non-community water systems. Armco responded on June 7, 1989, stating it will post notices in conspicuous places for three months beginning no later than June 30, 1989. A June 14, 1989, internal AK memo noted that water analyses for the past two years had lead concentrations ranging from 5.0 to 31.0 parts per billion (ppb). The standard for lead was 50 ppb at the time. Postings were required even though there were no violations of standard values.

Armco conducted routine sampling of potable water sources within the Site facility and reported the sampling information and analytical results to the Ohio EPA. A summary of the sample dates, reporting dates, sample locations, and sample results is shown in the table below.

Year	Sample Date	Reporting Date	Sample Location	Sample Result / Comments
1990	3/5/1990	3/23/1990	Pipe Shop water fountain	Sample was "safe" and total coliform <1/100 mL
	6/24/1990	9/26/1990	Pipe Shop water fountain	Sample was "safe" and total coliform <1/100 mL
	12/11/1990	1/23/1991	Pipe Shop water fountain	Sample was "safe" and total coliform <1/100 mL Armco indicated the Notice of Violation (NOV) for the quarter ending December 1990 was collected and submitted within the 40-day requirement; therefore, no violation occurred.
1991	3/19/1991	4/9/1991	Pipe Shop water fountain	Sample was "safe" and total coliform <1/100 mL
	7/30/1991	8/8/1991	Pipe Shop water fountain	Sample was tested total coliform "negative"
	10/16/1991	11/25/1991	Pipe Shop water fountain	Sample was tested total coliform "negative"
1992	4/22/1992	4/30/1992	Machine Shop water fountain	Sample was tested total coliform "negative"
	7/22/1992	8/3/1992	Machine Shop water fountain	Sample was tested total coliform "negative"

A June 28, 1991, letter from Ohio EPA indicated that a sanitary survey of the drinking water system was performed on May 31, 1991. The purpose of the survey was to evaluate the capability of Armco's collection, treatment, storage and distribution facilities. Ohio EPA issued the following comments:

- The review of records indicated that all required sampling was being performed as required, and no maximum contaminant levels had been exceeded since the last survey for all monitoring requirements including total coliform, nitrate, and volatile organics. Ohio EPA indicated that rule 3745-81-76 of the Ohio Administrative Code required evaluation of wells that were potentially influenced by surface water.
- The production well was said to be in good condition, with the only deviation being a lack of vent tubes.
- A well with a six-inch casing was noted in a pit near the chlorination building. This well had no cap, pump, or piping connected to it and was rusted almost completely off to the base of the pit. Ohio EPA considered this a serious threat to groundwater and recommended the well be repaired and maintained or abandoned.
- Ohio EPA indicated in its letter that Armco was not required to chlorinate the water because the system did not serve 1,000 people or more, on a routine basis. Armco was voluntarily chlorinating, which was acceptable, but chlorine residual testing had to be performed daily and records of levels made available for review.

On August 8, 1991, Armco issued a response to the June 28, 1991, Ohio EPA letter. The corrective actions listed for citation on the lack of production well vent tubes was the plugging of all well openings and placement of one vent tube extending from the pump base. Each vent tube was down turned and screened. The well with the six-inch casing was not part of an operating well system and had been out of service for many years. The well was to be abandoned and a steel cap was welded in place temporarily until that time. The chlorine residual analysis for the chlorinated water system began recording daily as of July 31, 1991.

On October 7, 1991, Armco issued a written response to Ohio EPA concerning the six-inch well casing near Well 10 at the New Miami plant. The well was abandoned on September 9, 1991 by proper well plugging procedures including plugging with amended bentonite grout. The abandonment information was submitted to the Ohio Department of Natural Resources.

On October 21, 1991, Ohio EPA issued a letter stating the Armco-Hamilton plant was in violation for failure to comply with bacteriological sampling and analytical requirements. Ohio EPA stated that Ohio requirements dictate water systems monitor once a quarter for coliform bacteria, but the Hamilton site failed to monitor the number of routine samples during the quarter of July-September 1991.

On October 23, 1991, Armco issued a response to the Ohio EPA's October 21, 1991, letter indicating that total coliform was collected and analyzed on July 30, 1991 and reported to Ohio EPA on August 8, 1991. A copy of the results and report were attached.

On a memo dated September 17, 1992, Armco noted a September 4, 1992, discussion regarding the production shutdown and low staffing of the Hamilton plant. With less than 25 people, Armco became exempt for state requirements on drinking water for coliform or volatile organics. Armco agreed to resume collection and analysis if staffing rose again to 25 people or more.

NPDES Permit
The NPDES permit (1ID00002*HD, OH0009989) was issued to the Hamilton Plant wastewater treatment plant for monitoring of three point sources: 200 – Sanitary Wastewater Treatment prior to discharge to the Great Miami River; 611 – Blast Furnace Recycle System Blowdown prior to discharge to the Great Miami River; and 801 – river water intake from the Great Miami River. Permit requirements were as follows:

- Monitoring point 200 was to be sampled and analyzed for color, odor, flow, turbidity, 5-day Biological Oxygen Demand (BOD5), pH, total residual chlorine, fecal coliform, and total non-filterable residue (i.e., total suspended solids – TSS).
- Monitoring point 611 was to be sampled and analyzed for flow, pH, ammonia, total lead, total zinc, phenol, and TSS.
- Monitoring point 801 was to be sampled and analyzed for flow and TSS.

On April 15, 1992, a Notice of Violation (NOV) was received from Ohio EPA for the January 1992 self-monitoring report for TSS on the monthly and weekly averages. No additional information was requested.

On April 30, 1992, a memo was received from Ohio EPA regarding submission of monthly reports by the 15th of each month.

Self-monitoring reports for July, August, September, October, November, and December 1993 were reviewed; all 12 months of 1994, 1995, 1996, 1997, 1998, 1999; and January through October 2000. No additional NOVs were appended to the files from these years.

On May 31, 2000, a letter was issued from Ohio EPA indicating that there was no longer any discharge from the New Miami plant to the waters of the State; therefore, a NPDES permit would no longer be required and would not be renewed. On December 14, 2000, AK Steel issued a memo to Ohio EPA Division of Surface Water Permit Compliance Unit stating that, because the NPDES permit was not renewed and was no longer deemed necessary by the Director of Ohio EPA, the Ohio EPA 4500 forms would no longer be submitted by AK Steel.

1.2.4 Previous investigations

A complete discussion of historical reports and previous site investigations is presented in the SSP (ENSR 2005), Section 2.8 (Previous Site Investigations – Existing Analytical Data).

1.3 Report organization

The RI report summarizes the results of the field investigation activities to characterize the site, the sources of contamination, the nature and extent of contamination and its associated impacts. The RI report is organized into the following nine sections and seven appendices:

- **1.0 Introduction**: includes a description of the regulatory background of the Site, the objectives of the RI/FS, the purpose of the RI report, and a description of the site, site history, and previous investigations.
- **2.0 Study area investigation design and implementation**: provides a description of the methodologies for conducting field investigation activities associated with the site characterization.
- **3.0 Physical characteristics of the study area**: describes the results of the field investigation activities to determine the physical characteristics of the site.
- **4.0 Nature and extent of contamination**: presents the results of the site characterization to provide information relative to natural and chemical components and contaminants within various media at the site.

- **5.0 Groundwater Fate and Transport:** presents a discussion of the fate and transport of site contaminants based upon currently available Site data and publicly available information regarding the New Miami Well Field and North Hamilton Well Field.
- **6.0 Baseline Human Health Risk Assessment (HHRA)**: a draft HHRA was submitted by ENSR to EPA in September 2006. EPA comments on the draft document were issued in August 2007. ENSR and EPA reviewed the comments in a September 2007 conference call, and written responses to comments issued by ENSR were dated September 21, 2007. EPA identified to KEMRON in May 2008 that the responses to comments were not received. The responses were re-issued in May 2007. EPA approved the responses with minor comments in a letter dated May 15, 2008. The revised HHRA is being submitted concurrently with this RI Report.
- **7.0 Baseline Ecological Risk Assessment (BERA)**: A draft Screening Level Ecological Risk Assessment (SLERA) was submitted to EPA on July 14, 2006. A Final SLERA was submitted by ENSR in March 2008, and subsequently approved by EPA in correspondence dated July 08, 2008. A biocriteria report was prepared and submitted in April 2008, presenting the results of a 2007 GMR fish and benthic survey. The data were collected to assess the integrity and well being of the fish and invertebrate community within the GMR upstream, adjacent to and downstream of the site. The biocriteria report was approved by USEPA and OEPA. Based on OEPA and EPA discussion with KEMRON and AK Steel in an April 28, 2008 project meeting, KEMRON prepared and submitted a Risk Assessment Assumptions Document (RAAD) in draft form in June 2008. In response to EPA and OEPA comments, a Revised RAAD was submitted in August 2008. The RAAD outlined the methodologies and assumptions that would be implemented in the BERA. The Draft BERA was prepared by KEMRON and submitted to EPA and OEPA concurrently with this RI Report.
- **8.0 Summary and conclusions**: provides a summary of the nature and extent of contamination and provides conclusions relative to any data limitations, recommendations for future work, and recommended need for a CERCLA response action for each AOC or Block.
- **9.0 References** and,
- **Appendices**: The following Appendices are included in this RI Report:
  - **Appendix A**: Soil boring logs;
  - **Appendix B**: Results of the potable well survey conducted within 800 meters of the site;
  - **Appendix C**: Geotechnical testing reports and findings;
  - **Appendix D**: CD-ROMs containing Analytical data tables of Region 5 EDDs from original RI, Region 5 EDDs from the 2008 Supplemental RI effort, and Complete Level IV analytical reports for the 2008 Supplemental RI effort laboratory analytical results.
  - **Appendix E**: Laboratory analytical data validation reports;
  - **Appendix F**: Hydraulic conductivity testing data analysis;
  - **Appendix G**: Conceptual Site Models from the Baseline Human Health Risk Assessment and Baseline Ecological Risk Assessment.

2.0 Study Area Investigation Design and Implementation

This section presents a summary of the field investigation design and methodologies. A complete description of the field investigation activities is presented in the Site Sampling Plan (ENSR 2005) and Field Sampling Plan (ENSR 2005). All sampling locations for the 2005 through 2008 site Remedial Investigation are shown on Figures 2.1, 2.2, 2.3, and 2.4.

2.1 Contaminant source investigations

2.1.1 Geophysical Investigation

An integrated geophysical investigation was performed within the selected locations at the former Armco Hamilton Plant located at 401 Augspurger Rd. and a former landfill parcel located north of the Hamilton plant works with both of these areas located in New Miami, OH (referred to as "Site"). The primary purpose of the geophysical investigations was to identify former historical site features, such as pits, sumps, pipelines, basins and manholes, where process wastes may have been placed or conveyed. Borings were then located in identified areas of concern to evaluate each subsurface anomaly, or the locations previously proposed borings (i.e., from the soil sampling program) were adjusted to investigate the anomaly. Geophysical surveying was limited to seven areas of concern (AOC) within the area of investigation. These investigative areas consisted of AOC 2 (Former Landfill), AOC 13 (Former Byproducts Area), Block E (Former Quenching Station Area), AOC 8 (Former Railcar Thaw Area and Former Fuel Oil UST), AOC 14 (Former Transformer and Compressor Area), AOC 9 (Former Fuel Oil UST's), and AOC 11 (Former Gasoline UST) and encompassed a total of approximately 16.5 acres. Professional geophysical services were completed in accordance with EPA-approved workplans (ENSR 2005). The results of the geophysical investigations are summarized in Section 4.0.

2.1.2 Scope of Work

Geophysical surveying consisted of several investigative objectives, and these objectives varied depending on previous land usage and potential existing buried targets in each of these areas. The primary goal within AOC 2 (approximately 5.7 acres) was to non-intrusively map lateral limits of buried waste by integrating frequency-domain electromagnetic and vertical magnetic gradient methods over the landfill footprint. A Geometrics G-858G Cesium Vapor Gradiometer was employed to map the vertical magnetic gradient response and a Geonics EM-31DL to map ground conductivity and magnetic susceptibility subsurface variations. The Geometrics G-858G will detect buried ferrous metallic targets while the EM-31 is sensitive to both ferrous and non-ferrous targets, elevated soil salinity, leachate, and high total dissolved solids in groundwater. Depth of exploration for the gradiometer is estimated at 20 ft below ground surface (bgs), and the fixed coil separation of the ground conductivity meter can provide an estimated depth of investigation to approximately 15 ft.

The primary objective within AOC 13 (approximately 10.5 acres), Block E (approximately 0.55 acres), AOC 8 (approximately 0.6 acres), and AOC 14 (approximately 0.2 acres) was an attempt to delineate anomalies (e.g., former USTs, pits, sumps, and buried lines) for further site characterization by targeted drilling and test pit activities. AOC 13 was surveyed, due to proximity, to include AOC's 11, 14, 15, and 18. The use of geophysical surveying was performed in an attempt to non-intrusively map former subsurface utility lines that may potentially provide preferential contaminant pathways. Frequency-domain and time-domain electromagnetic (EM) methods were used to measure bulk ground conductivity changes and buried metallic targets in the shallow subsurface. Interpreted anomalies were then followed by further delineation using ground-penetrating radar (GPR). This allowed for an estimation of depth to target and more delineated target footprint.

In areas of former or potential in-place USTs, geophysics was used in an effort to confirm the presence of these features. These areas included AOC 8 (approximately 0.6 acres), AOC 9 (approximately 0.2 acres), and AOC 11 (approximately 0.1 acres). The presence of a metallic UST can result in elevated conductivity and magnetic susceptibility variations. Removal of an UST and subsequent backfilling of the excavation can potentially result in conductivity variations since backfill materials may be comprised of non-native derived soils with varying degrees of compaction and moisture content that can contrast with the surrounding soil conditions. Frequency-domain and time-domain electromagnetic (EM) methods were used to measure bulk ground conductivity changes in the shallow subsurface. GPR was used in an effort to estimate the depth of EM anomalies and to aid in target delineation.

2.1.3 Geophysical Methods

During the original RI phase, vertical magnetic gradient/gradiometer, frequency and time-domain EM, and GPR geophysical methods were performed to meet the project objectives. A brief technical explanation of each geophysical method is as follows:

<u>Time-Domain Electromagnetic Induction</u>
Time-domain EM is essentially a non-intrusive metal detection geophysical technique that uses an alternating magnetic field to induce eddy currents in buried conductive materials. The rates by which these currents dissipate are monitored after the alternating signal is switched off. This rate of signal decay is slower for metallic objects, resulting in higher millivoltage (mV) readings over metallic targets. Decay rates in metallic objects buried deeper persist longer than for shallower objects.

A Geonics Limited EM-61MK2 instrument with digital data logger for the survey was used. This instrument provides an increased dynamic range versus most other commercially available metal detection instruments. The EM-61 system also provides several advantages for buried metal detection. First, the EM-61 system is designed to induce eddy currents in a near-vertical section. This permits data collection proximal to some surface features (such as buildings or vehicles) that generally would cause interference with magnetometers or frequency-domain EM instruments. Secondly, the vertical signal generated from a buried target stops responding to the primary signal once the 1 x 0.5 meter coils have been towed past the vertical projection of the buried metallic feature. The vertical projection, combined with the high dynamic range, can provide increased lateral resolution for mapping of utilities, USTs, reinforced concrete, and other buried metallic targets.

The estimated maximum depth of penetration for EM-61 instrumentation is less than 8 ft below surface. The EM-61 is designed to sense subsurface metallic targets and to minimize interference of metallic structures at or near the surface that are greater than 5 ft laterally from the instrument. However, misleading high-amplitude responses recorded near buildings, vehicles, or over reinforced concrete, for example, can mask the response of buried objects.

Frequency-Domain Electromagnetic Induction

Frequency-domain EM is essentially a non-intrusive ground conductivity and metal detection geophysical technique implemented to map subsurface electrical conductivity variations. An electromagnetic field generated by the instrument is induced into the ground and is altered by the heterogeneity of the material. The resulting difference between the generated (primary) and received (secondary) EM fields are recorded, processed, and interpreted to reveal the nature of the anomaly.

A Geonics Limited EM-31DL instrument with digital data logger was employed for the survey. The EM-31 output includes two separate modes of data that provide the operator with similar as well as contrasting subsurface information regarding earthen materials or man-made targets. For instance, ground conductivity (quadrature-phase) readings (measured in milliSiemens/meter [mS/m]) are particularly sensitive to buried metal as well as qualitative variations in salinity or total dissolved ionizing solids within groundwater, air voids (e.g., tunnels and sinkholes), conductive soils (e.g., cinders and ash), and relative subsurface saturation. In-phase (magnetic susceptibility) mode data are a unitless component of the secondary electromagnetic field (measured in parts per thousand [ppt]). In-phase response is sensitive to both ferrous and non-ferrous metallic targets. For typical shallow EM-31 investigations, both ground conductivity and in-phase data are recorded in an effort to locate buried metal targets (e.g., USTs), metallic and non-metallic underground utility lines, and shallow groundwater saturated zones.

Frequency-domain EM values represent a composite value for all geo-electric layers or anisotropic media within a predicted zone of exploration. The EM-31 consists of a cylindrical boom housing the transmitter and receiver coils that have an intercoil spacing equaling approximately 12 ft (3.66 m). Depth of exploration is dependent on the transmitter and receiver coil separation and orientation. The 12-ft fixed-separation and vertical dipole mode configuration employed for this investigation can detect conductive responses to approximately 15 ft bgs.

Magnetic Gradiometer

Magnetometer surveying involves measuring the magnetic field of the earth at discrete points to observe and map abnormal geomagnetic field variations. The presence of ferrous metallic materials alters the natural magnetic field of the earth in both magnitude and direction, thus creating magnetic anomalies. The magnitude and extent of these anomalous responses are dependent on several variables, including target to magnetic sensor distance (depth), target material, mass, and orientation.

For shallow magnetic surveying, magnetic gradiometry is typically employed utilizing two vertically separated magnetic sensors to measure the magnetic gradient over a specified location. This technique allows for a higher level of accuracy in areas of increased relative magnetic backgrounds such as slag-rich soils and/or backfill materials. The 1 m (3.28 ft) vertical separation of the sensors permits data collection proximal to some surface features (such as buildings or vehicles) that generally would cause interference with single-sensor magnetometers or frequency-domain EM instruments. The bottom sensor is carried approximately 2 ft above the ground surface. The advantage of using a gradient magnetometer as opposed to a total field magnetometer is the elimination any diurnal changes in the earth's magnetic field.

A Geometrics, Inc. G-858G Cesium Vapor Gradiometer instrument with digital data logger was employed for the survey. Since the survey was conducted using a gradiometer, a magnetic base station was not necessary to correct for diurnal or other time-variant magnetic "noise." Depth of exploration for the gradiometer is estimated at 20 ft bgs and this instrument is capable of measuring variations in the magnetic filed of the earth to 0.1 nanoteslas (nT). The data logger allows for a higher sample rate while maintaining accuracy when integrated with a Differential Global Positioning System (DGPS).

Ground Penetrating Radar

GPR is a non-destructive, non-invasive geophysical method for subsurface imaging to locate buried features. GPR can detect a variety of metallic, non-metallic, natural and manmade targets to include underground utilities, UST's, rebar, sinkholes, and voids.

GPR emits a series of high-frequency, high amplitude EM pulses (radio waves) from a transmitting antenna into the ground. When the EM pulses encounter materials that differ in electrical properties, a portion of the energy is reflected back to a receiving element (antenna) at the surface. These reflections are collected as digital images and fed to a portable computer, which then displays a real-time continuous "picture" or profile of the subsurface that can be used to pinpoint the location of the subsurface feature.

For greater vertical and lateral resolution, the frequency of the emitted radar wave can be increased. However, greater accuracy and resolution is achieved at the expense of depth of penetration. Depth of penetration is also dependent upon the geologic conditions of the soils in which the investigation is being performed. The radar waves may be absorbed or scattered depending on the properties of the soil, particularly electrical conductivity. Electrically resistive material such as unsaturated, coarse-grained sediments optimize GPR signal penetration, whereas exploration depths are limited by relatively conductive material such as saturated or fine-grained sediments, clay-rich soils, ash, or reinforced concrete.

A GSSI SIR-2000 GPR system was employed, mounted on a mobile cart to aid in data collection over rough terrain and outfitted with a 400 megahertz (MHz) antenna in an attempt to image subsurface targets. Typical radar depth of penetration using this antenna ranges from 4 to 6 ft in developed urbanized setting. For example, effective depth of penetration can be variable with upwards of 8 ft or more in dry sandy soils and 4 ft or less in conductive clay-rich fill material.

2.1.4 Field Data Collection

Data collection for the 2005-2006 RI field work was based upon a control grid using either wooden stakes or flagging prior to the start of data collection in each of the AOCs. The survey area within AOC 2 was limited by the perimeter fencing whereas other AOCs were staked based on the per-determined corner coordinates (per EPA-approved workplan). These survey limits were located using GPS navigation and existing site features. AOC 13 (Former By-Products Area) was expanded to include adjacent AOCs 11, 14, and 15. 10-ft spaced intermediate north-south survey control using marking paint was placed along either 100 or 200 ft control grid (dependant upon size of AOC) to aid in maintaining profile orientation during geophysical data collection. Small AOCs were bisected using control stakes located at opposite ends of the survey areas.

EM-31, magnetic gradiometer, and EM-61 data collection consisted of walking north-south or northeast-southwest traverses generally oriented parallel to the long axis of the AOC. These profiles were spaced approximately 5-ft apart over the AOCs and were traversed by bisecting the survey control grid. On average, geophysical data points were spaced approximately 2-ft apart along profiles based on a 1 sec. average digital logging rate.

A Trimble GeoXT (DGPS) was integrated with the geophysical instrumentation as a means of maintaining location (x,y) control of geophysical data points. DGPS data were collected at approximately 1 sec. intervals, similar to geophysical data logging rates, along geophysical profiles, allowing for a station spacing of approximately 2-3 ft. These position data were collected in the Ohio South State Plane Coordinate System (NAD 83 Geodetic Datum) and were merged with EM and magnetic data files to create a (x, y, z) dataset to be visualized by contouring software.

GPS data were differentially corrected to a CORS (Continuously Operating Reference Station) site located in Galbraith, Ohio. Differential correction is necessary as a means of QA/QC and to allow for sub-meter accuracy of the GPS. In addition, differential correction is needed to correct for periodic loss of the real-time differential signal by the GPS that can be caused by overhead obstructions (e.g., tree cover). Differential signals allow for sub-meter accuracy of the GPS and in order to maintain the accuracy and consistency between GPS files over time (some AOCs were collected over a period of two days).

Gradiometer, EM-61 and -31 data were downloaded to a laptop computer in the field and data were reviewed for QA/QC purposes daily. Geophysical and GPS data files were merged in the field using software developed by Geonics, Ltd. and Geometrics, Inc. to ensure data consistency, density, and coverage. In total, 42450 EM-31 data points, 28530 EM-61 data points, and 11855 magnetic data points were collected, and an (x, y) GPS location was tied to each geophysical data point location. Preliminary contour maps were generated with Surfer v8.0 software using the statistical kriging algorithm and evaluated in the field.

GPR profiling was conducted over interpreted EM and magnetic anomalies observed from preliminary in-field contour maps. GPR profiles were oriented in intersecting, perpendicular directions over geophysical anomalies using a 50 ns recording time. Radar profiles were digitally collected and stored to computer for post-processing and interpretation purposes.

2.2 Meteorological investigations

To evaluate the local effects precipitation has on groundwater elevation and fluctuation across the Site, precipitation was monitored throughout the RI. Precipitation data was obtained by accessing meteorological information in the vicinity of the Site, which was obtained electronically through the National Climatic Data Center (NCDC) and the National Oceanic and Atmospheric Administration (NOAA). The data were obtained from the nearest meteorological station, Hamilton Butler County Region meteorological station, which is located approximately 4 miles south-southeast of the Site (Lat. 39°22'N, Long. 84°31'W). Parameters available from meteorological stations include: temperature, wind speed, wind direction, sky conditions, visibility, dry bulb temperature, and precipitation amounts in the form of rainfall and snowfall.

2.3 Surface water and sediment investigations

2.3.1 Surface water elevation monitoring

The SSP initially included the installation of six river staff gauges, however, steep banks and a wide, flat coarse cobble floodplain prohibited the installation of all but two of the staff gauges. The steep banks along the northern portion of the site prevented safe access to the shoreline of the GMR. The wide cobble floodplain along the southern portion of the site prevented the easy installation of a stable monitoring point, and when the river rose, the staff gauge was an obstacle to river traffic.

Two staff gauges were installed to measure surface water levels within the Great Miami River. One staff gauge was installed upstream (SG-3) and one staff gauge downstream (SG-1) of the Site. The top of each staff gauge was surveyed and referenced to the established vertical datum. Surface water elevations were recorded monthly in conjunction with the groundwater elevation measurements to correlate the groundwater and river stage elevations for proper gradient and groundwater-surface water interaction interpretations. Shortly after SG-1 and SG-3 were installed, the GMR flooded and both staff gauges were destroyed. The staff gauges were replaced at new locations, however, SG-1 was again destroyed due to high water and floating debris. SG-2 remains in place and SG-3 was dry (the river had receded beyond the staff gauge) at the last gauging event.

Real-time river stage data were collected using the United States Geological Survey (USGS) website, which provides current hourly stream flow data for surface water systems throughout the United States. USGS data were used to compare and verify the measurements collected at the Site river staff gauges and to assess long-term influences/fluctuations in surface water interaction at the Site. A gauging station upstream of the Site (USGS 03272100 Great Miami River at Middletown OH) is located approximately 10 miles northeast of the Site (Lat. 39°31'12"N, Long. 84°24'51"W). The gauging station is 626 feet above mean sea level and is located on the northwest side of the city of Middletown, on the downstream side of the Central Avenue Bridge on State Route 122 and approximately 1.9 miles downstream from Browns Run. A downstream river gauging station (USGS 03274000 Great Miami River at Hamilton OH) is located approximately 3 miles south-southwest of the Site (Lat. 39°23'28"N, Long. 84°34'20"W). The gauging station is 499.98 ft above the National Geodetic Vertical Datum of 1912 and is located on the east bank of the Great Miami River, 1,000 feet downstream from the Columbia Bridge at Hamilton and 3 miles downstream of Four Mile Creek.

Parameters available from the gauging station include discharge (measured in cubic feet per second), gauge height/water surface elevation (in feet, relative to the gauge datum), and total precipitation (measured in inches).

2.3.2 Sediment and surface water sampling

2.3.2.1 2005 Sediment and Surface Water Sampling

A surface water and sediment investigation was conducted to determine the level and presence of contaminants attributable to Site sources reaching the Great Miami River via surface water discharge from the Site, from the former outfalls, or from the drainage ditch adjacent to the Closed Landfill. The sediment and surface water investigation was also implemented to determine the level and extent of potential contamination within the drainage ditch (AOC 7). A separate sediment and surface water investigation was performed upstream of the Site where the former COG pipeline (AOC 19) crossed beneath the GMR.

Upstream and downstream of Site

Surface water and sediment samples were collected at locations upstream and downstream of the Site as well as at the northern end of the southern parcel.

- Upstream of the Site boundary and intermittent stream to provide data prior to the Site boundary:
- – Surface Water: **GMRSW-09**
- – Sediment: **GMRSD-15**
- Downstream of the Site to evaluate potential downstream sediment and surface water impacts downstream of the Site:
- – Surface Water: **GMRSW-05**
- – Sediment: **GMRSD-08**
- Northern end of the southern parcel to evaluate potential sediment impacts at the southern end of the northern parcel:
- – Sediment: **GMRSD-09**

Former outfalls

To evaluate potential impacts to the Great Miami River near the former outfalls and downstream from the former outfalls, surface water and sediment samples were collected at the following locations:

- Downstream of each of the four former outfalls
- – Surface Water: **GMRSW-01**, **GMRSW-02**, **GMRSW-03**, and **GMRSW-04**
- – Sediment: **GMRSD-01**, **GMRSD-02**, **GMRSD-03**, and **GMRSD-04**
- Midway between each of the four former outfalls
- – Sediment: **GMRSD-05**, **GMRSD-06**, and **GMRSD-07**

Drainage ditch (AOC 7)

To evaluate the surface water and sediment quality within the drainage ditch adjacent to the closed landfill and to determine potential impacts to the Great Miami River at the point where the drainage ditch discharges to it, surface water and sediment samples were collected at the following locations:

- Within the drainage ditch
- – Surface Water: **AOC7SW-06** and **AOC7SW-07**
- – Sediment: **AOC7SD-10**, **AOC7SD-11**, **AOC7SD-12**, and **AOC7SD-13**
- Within the Great Miami River where the intermittent stream terminates in the river.
- – Surface Water: **AOC7SW-08**
- – Sediment: **GMRSD-14**

Former COG pipeline crossing (AOC 19)

To evaluate the surface water and sediment quality in the Great Miami River near where the former COG pipeline previously crossed under the river, surface water and sediment samples were collected at the following locations:

- Surface Water: **GMRSW-10** (downstream of the former crossing) and **GMRSW-11** (upstream of the former crossing)
- Sediment: **GMRSD-16**, **GMRSD-17**, **GMRSD-18** (downstream of the former crossing), and **GMRSD-19** (upstream of the former crossing)

Grab sediment and surface water samples were collected. At locations where paired surface water and sediment samples were collected, the grab surface water sample was collected first, followed by the grab sediment sample. Sediment and surface water samples were collected in accordance with the procedures outlined in SOP 103 (Surface Water and Sediment Sample Collection) and the document, *Sediment Sampling Guide and Methodologies (2nd Edition), OEPA, Division of Surface Water, November 2001.*

Sediment samples were laboratory analyzed for TCL VOCs, TCL SVOCs (including PAHs), PCBs, TAL metals, and FOC. Twenty-five percent of the sediment samples were analyzed for acid-volatile sulfides and simultaneously extracted metals (AVS/SEM). The surface water samples were laboratory analyzed for TCL VOCs, TCL SVOCs (including PAHs), PCBs, and TAL metals (total).

2.3.2.2 2007 Sediment Sampling

Additional sediment sampling was conducted in the GMR in September 2007. The sediment sampling and analysis activities were conducted to address data gaps and provide a comprehensive set of physical, chemical, and biological data for the Great Miami River adjacent to the Site. Samples were located adjacent to the Site in order to further delineate the chemical distribution in the sediment in the vicinity of the Site and upstream of the Site to evaluate anthropogenic background conditions in the vicinity of the Site.

Sediment samples were collected in conjunction with biological sampling for macroinvertebrates and finfish. A total of 15 sampling locations were selected based on a review of the historic data (i.e., sediment and groundwater samples evaluated in the Screening Level Ecological Risk Assessment (ENSR, 2008). These data were used to further characterize the sediments adjacent to the Site, to assess the potential for groundwater discharge to the river from upland AOCs, and to address the recent observations of tar-like material in the floodplain. A sub-set of 13 surficial sediment samples were collected from 5 zones of the stream where fish biocriteria studies were conducted, and 11 discrete sampling locations were co-located spatially with macroinvertebrate biocriteria sampling stations.

Sediment samples were analyzed for metals, PCBs, PAHs, TOC, simultaneously extracted metals (SEM), and acid volatile sulfides (AVS). Methodologies for sample collection, processing, and analysis were consistent with those presented in the Remedial Investigation/Feasibility Study Support Sampling Plan for the Former ARMCO Hamilton Plant Site (ENSR, 2005) and in the OEPA Sediment Sampling Guide and Methodologies (OEPA, 2001).

A thorough presentation of the sediment sampling locations, analytical results and their interpretation were evaluated through the Site BERA (KEMRON, November 2008).

2.4 Geotechnical investigations

To characterize the subsurface soils for geotechnical parameters, California samplers (Shelby tube samples) or bag samples were collected from 18 locations during the initial RI. Samples were collected in the vicinity of or from the borehole of monitoring wells: MW-3S, MW-4M, MW-5S, MW-6S, MW-6M, MW-7S, MW-7M, MW-8M, MW-10M, MW-11S, MW-12M, MW-14S, MW-18S, MW-19S, MW-20M, MW-21M. California samplers were also collected within the closed landfill at AOC2SB2 and AOC2SB13.

Bag samples were laboratory analyzed for fractional natural moisture content, liquid limit, plastic limit, plastic index, specific gravity, and particle size. California samplers collected from AOC2 were laboratory analyzed for fractional organic carbon, soil moisture content, soil pH, grain size, permeability, and soil bulk density. California samplers collected from monitoring well locations were laboratory analyzed for dry bulk density, particle size analysis, vertical hydraulic conductivity, and porosity.

2.5 Soil and vadose zone investigations

2.5.1 Investigation of Areas of Concern (AOCs) and Former Production Areas (Block Areas)

As described in the USEPA approved SSP and FSP, the soil sampling program was based on the EPA DQO Guidance and the Visual Sampling Plan Methodology developed by DOE for investigation and characterization of the identified Areas of Concern (AOCs) and former production and slag processing areas (Block Area). Surface and subsurface soil samples were collected from each AOC and Block Area based on one of three sampling protocols:

- Grid sampling (with or without Composite Samples of grid samples);
- Biased sampling; or
- Random sampling.

Areas not identified for biased sampling were selected for either grid or random sampling. Areas less than two acres in size were selected for random sampling, whereas areas greater than two acres in size were selected for a grid sampling pattern. Areas that previously contained underground structures were initially investigated using geophysical methods. The results of the geophysical investigations were used to refine the soil boring and sampling program and ensure that a comprehensive investigation was performed.

2.5.1.1 Grid sampling

Each AOC and Block Area selected for grid sampling during the original RI effort was divided into grid cells or Composite Areas, following the Visual Sampling Plan guidance. The number of grids/Composite Areas was selected based upon the size of the area to be sampled and the expected distribution of the data. In Areas with large grids (greater than 250 feet by 250 feet), the Composite Areas were subdivided into smaller sub-grids to increase the surface and subsurface soil sample coverage; samples were collected from each sub-grid, and composite samples were analyzed. In Areas where individual grids sizes were less than 250 feet by 250 feet, one surface sample and at least two subsurface samples were collected per grid cell and no composite samples were analyzed.

Grid sampling with composite sampling was conducted in **AOC 1**, **AOC 20**, and **Block A**. Grid sampling without composite sampling was conducted in **AOC 13**, **Block C**, and **Block G**.

Composite samples

Composite Areas within AOC 1, AOC 20, and Block A were subdivided into smaller sub-grids (see table below for details of the composite areas and sub-grids within each). One boring was installed in each of these sub-grids, and one surface soil sample and at least two subsurface soil samples were collected from each boring. A composite sample was submitted from each grid for analysis of non-VOC parameters. Since VOC samples cannot be composited, discrete VOC samples were selected based on the highest PID reading from the surface sample, the sample above the capillary fringe, and the intermediate zone sample in each Composite Area (i.e., for VOCs, at least one surface sample and two subsurface samples from each Composite Area were selected for analysis). Additional discrete VOC samples were analyzed from other borings if the field geologist or sampling technician believed that sampling was warranted based upon the sample characteristics such as visible contamination, PID readings, or soil type.

Area	Composite Areas	Composite Area Size	Sub-Grids/ Composite Area	Total Sub-Grids
AOC 1	13	293 ft x 293 ft	2 – 7	61
AOC 20	13	500 ft x 500 ft	2 – 4	36
Block A	13	400 ft x 400 ft	2 – 6	56

Non-composite samples

AOC 13, Block C, and Block G were each divided into 13 grid cells for non-composite grid sampling. Thirteen borings were installed in each of AOC 13 (**AOC13SB1** through **AOC13SB13**), Block C (**BCSB1** through **BCSB13**), and Block G (**BGSB1** through **BGSB13**). Borings were advanced to the clay confining layer or to the capillary fringe.

2.5.1.2 Biased sampling

During the original RI effort, biased sampling was selected for **AOC 8**, **AOC 10**, **AOC 12**, **AOC 14** and **AOC 15**, **AOC 18** and **AOC 19**, and **AOC 21**. The following borings were collected from these Areas:

- AOC 8: Five borings were installed throughout the former railcar thaw areas (**AOC8SB1** through **AOC8SB5**). Borings were advanced to the clay confining layer or to the capillary fringe.
- AOC 10: Four borings were installed throughout the former fuel oil AST storage area (**AOC10SB1** through **AOC10SB4**). Borings were advanced to approximately four feet bgs or to a depth immediately below any fill material in the area.
- AOC 12: Six borings were installed within the former wastewater settling ponds (**AOC12SB1** through **AOC12SB3** in the west sludge pond and **AOC12SB4** through **AOC12SB6** in the east sludge pond). Borings were advanced to the clay confining layer or capillary fringe.
- AOC 14: Four borings (**AOC14SB1** through **AOC14SB4**) were advanced to the clay confining layer or to the capillary fringe.
- AOC 15: Four borings (**AOC15SB1** through **AOC15SB4**) were advanced to the clay confining layer or to the capillary fringe.

- AOC 18: Six borings (**AOC18SB1** through **AOC18SB6**) were advanced to approximately 8 feet.
- AOC 19: Thirteen borings (**AOC19SB1** through **AOC19SB13**) were advanced to approximately 8 feet.
- AOC 21: Thirteen borings (**AOC21SB1** through **AOC21SB13**) were advanced to the clay confining layer or to the capillary fringe.

2.5.1.3 Random sampling

Random sampling was selected for **Block B**, **Block D**, **Block E**, and **Block F**, which were not selected for biased sampling in the first RI phase and were smaller than 2 acres. Eight borings were advanced within each of Block B (**BBSB1** through **BBSB8**), Block D (**BDSB1** through **BDSB8**), Block E (**BESB1** through **BESB8**), and Block F (**BFSB1** through **BFSB8**). Borings were advanced to the clay confining layer or to the capillary fringe.

Additional sampling

- AOC 2: Eleven borings were installed along the outside of the closed landfill perimeter (AOC2SB1 through AOC2SB11). Borings were advanced to the clay confining layer or to the capillary fringe. Three borings were installed within the closed landfill (AOC2SB13 through AOC2SB15).
- Background Sampling: Thirteen borings (BGSLAG-1 through BGSLAG-3, BG1, BGRR-2 through BGRR-4, BGPRK, BGVNM-6, BGVNW-7, BGCOG-1 through BGCOG-3) were advanced to target depths.
- Based on the results of the geophysical investigations, additional shallow borings were advanced in identified historical locations that contained sumps, pits, basins, pipelines, etc.

2.5.1.4 Supplemental RI Sampling (Summer 2008)

A supplemental sampling investigation was completed in the May through August 2008 time period . Supplemental RI sampling was conducted in accordance with an approved Supplemental Work Plan (SWP), originally drafted by ENSR in September 2007, revised by KEMRON in May 2008 in response to USEPA comments on the revised draft (April 2008), and subsequently approved by USEPA. The 2080 program also conformed to the Site FSP. The sampling locations were selected to fill data gaps intended to finalize the delineation of potential constituents of concern at the Site.

Supplemental RI sampling was conducted between May 28 and August 12, 2008 by KEMRON environmental sampling technicians, geologists and other scientists, with soil boring and well installation services provided by Geo-Environmental Drilling of Pittsburg, PA. Laboratory analytical services were provided by Microbac Laboratory of Marietta, OH for the majority of analytical services. Selected analytical (dioxins/furans) services were provided by Columbia Analytical. Supplemental RI soil boring and well installation locations were surveyed by Tecumseh Surveying of Cincinnati, OH.

All 2008 Supplemental RI sampling locations were based upon pre-selected, USEPA approved locations designed to fill data gaps such that the RI data set would be complete. Planned sampling locations were agreed upon in advance with the USEPA prior to mobilization to the site.

The pre-determined locations were marked in the field, measured from GPS coordinates for prior sampling locations, and flagged. The flagged locations were documented in the field using Trimble GeoXT (DGPS) instrumentation. Other than AOC 22 sample locations, all completed supplemental sample locations, including both soil borings and monitoring wells, were surveyed by a professional, licensed surveyor. Project sampling activities were viewed on a full-time basis by a project oversight subcontractor assigned by the USEPA. For this project, field oversight was provided by SulTRAC.

Additional sampling was targeted for **AOC-1**, **AOC 2**, **AOC 9**, **AOC 13**, **AOC 20, AOC 22, and Blocks B, D and G**. The following boring/sampling activities were completed in these Areas:

- AOC-1: One (1) soil boring (AOC1CA6SB5) was completed to delineate soil conditions south of AOC1CA6SB4. The soil boring was completed to a depth of 26 feet below ground surface (bgs). Soil samples collected from this boring were analyzed for TAL Metals, TCL VOC, TCL SVOC, and PCBs. No monitoring well was installed at this location.
- AOC-2: Soil boring/monitoring well MW-17M was completed to assess soil and groundwater quality at depths greater than existing co-located well MW-17S. Soil samples collected from this soil boring were analyzed for TAL Metals, TCL VOC, TCL SVOC, and PCBs. Monitoring well MW-17 was installed and screened from a depth of 30 to 40 feet bgs.
- AOC-9: Two (2) shallow monitoring wells (MW-23S and MW-24S) were installed to assess groundwater within AOC-9. Soil samples collected from these soil borings were analyzed for TAL Metals, TCL VOC, TCL SVOC, and PCBs. Both monitoring wells were installed and screened from a depth of 20 to 30 feet bgs.
- AOC-13: This AOC was assessed with the completion of one (1) soil boring (AOC13SB57) and six (6) monitoring wells (MW-25S, MW-27S and -27M, MW-28S, MW-29S, and MW-31S). Selected soil samples collected from these soil borings were analyzed for TAL Metals, TCL VOC, TCL SVOC, and PCBs. Individual shallow monitoring wells were installed and screened at depths ranging from 8 to 18 feet bgs (MW-27S) to 12 to 22 feet bgs (MW-25S). Intermediate depth well MW-27M was installed and screened from a depth of 25 to 35 feet bgs adjacent to MW-27S.
- AOC-20: This AOC was assessed with the completion of five (5) soil borings (AOC20CA4SB3A and 3B, AOC20CA4SB4, AOC20CA12SB3, and AOC20CA12SB4), and one (1) monitoring well (MW-32S). Selected soil samples collected from these soil borings were analyzed for TAL Metals, TCL VOC, TCL SVOC, and PCBs. Monitoring well MW-32S was installed and screened from a depth of 18 to 28 feet bgs.
- AOC-22: Shallow soil/waste material samples (labeled AOC22RA01 through AOC22RA17) were collected in the Riparian Area to evaluate residual contamination in this area. At most locations, environmental samples were collected to a depth of less than one-foot below ground surface using hand augers and trowel-type equipment. Soil samples collected from these soil borings were analyzed for TAL Metals, TCL VOC, TCL SVOC, PAH and PCBs. Three (3) additional samples, (identified as AOC22TAR1 through AOC22TAR3) were collected from tar-like material observed on the ground surface within the Riparian Area. Samples collected of the tar-like materials were analyzed for TAL Metals, TCL VOC, TCL SVOC, PAHs, PCBs, and dioxins/furans.
- Block B: One (1) shallow soil boring location (AOC22RA18) was positioned southwest of Block B. A soil sample collected from this boring was analyzed for TAL Metals, TCL VOC, TCL SVOC, PAHs, PCBs, and dioxins/furans.

- Block D: Two(2) soil borings (BDSB9 and BDSB10) and one (1) monitoring well (MW-26S) were completed in the Block D area. Soil samples collected from these soil borings were analyzed for TAL Metals, TCL VOC, TCL SVOC, PAHs and PCBs. Monitoring well MW-26S was installed and screened from a depth of 12 to 22 feet bgs.
- Block G: One (1) monitoring well (MW-30S) was installed within Block G. Soil samples collected from the soil boring were analyzed for TAL Metals, TCL VOC, TCL SVOC, PAHs and PCBs. Monitoring well MW-30S was installed and screened from a depth of 12 to 22 feet bgs.

2.5.2 Monitoring well installation program

Monitoring wells were installed in accordance the decision trees for installation as presented in the project FSP (ENSR, 2005).

Shallow monitoring wells were installed using hollow-stem auger (HSA) drilling techniques. Soil borings were advanced to the either the perched water above any clay confining unit or to the first groundwater encountered at the particular boring location.

Intermediate wells were installed immediately adjacent to selected shallow monitoring well locations. Intermediate wells were installed using both HSA and sonic drilling techniques. Soil borings were advanced within the upper water bearing unit to the first clay confining unit using the HSA. Dual casing installation methods were used to install an 8-inch diameter steel casing into the top of the upper clay confining unit. The casing was cemented and grouted to effectively "seal off" the upper water bearing unit. Soil borings were advanced through the steel casing using sonic or HSA drilling techniques. Soil borings were advanced below the upper clay confining unit, if present, to the intermediate water bearing zone or any lower clay confining unit, whereupon the intermediate well was installed.

2.5.3 Surface and subsurface soil sampling

Surface soil samples were collected using trowels and/or hand augers. Subsurface soil samples were collected using HSA, Geoprobe, or sonic drilling equipment, and soil borings were advanced to the clay confining unit or the ground water table. Split-spoon samples were collected continuously from each borehole from ground surface to the target depth. Upon retrieving each split-spoon sample, the soil sample was extracted, inspected, described for gross composition, color, texture, relative degree of saturation, and other observable soil characteristics in accordance with the procedures detailed in SOP 109 and SOP 7115 in Appendix A of the FSP. Each soil sample was also field-screened with a PID utilizing standard headspace screening methods. Individual soil samples were logged onto a field boring log by the inspecting geologist. Field PID results were also recorded on the boring logs.

At least three samples (one surface soil sample and two subsurface soil samples) were collected from each boring for laboratory testing. One surface soil sample was collected at the surface (0-2 ft bgs), and one subsurface soil sample was collected just above the water table or at the first clay confining unit. Intervening subsurface soil samples were collected at one or more of the following levels:

- If fill material or slag was present, one soil sample was collected in the natural soils encountered immediately beneath the fill or slag.
- Additional samples were collected if high PID readings (e.g., sustained readings greater than 100 units) were observed or there were visual observations of staining or impact (not necessarily including common site fill material such as slag). These samples were intended to accurately define the depth of impacted soils, and the spacing of the samples was at the discretion of the site geologist. Consequently these samples were at various intervals depending upon the nature of the actual material encountered.
- If no anomalies were observed the third sample was collected at 5 feet below grade.

For sampling conducted in 2006, soil samples were analyzed for TAL metals and cyanide, TCL VOCs, SVOCs, PCBs, PAHs, and dioxins and furans as outlined in Table 1 of the FSP or Table 1 of the SWP. As specified in the final USEPA-approved SWP, 2008 sampling was generally consistent with prior analyses. The 2008 soil sampling and analysis were conducted for TAL metals, TCL VOCs, SVOCs, PCBs and PAHs; neither dioxins/furans nor cyanide were included in the soil analyte list for the 2008 supplemental RI. If field observations did not indicate significantly high levels of PAHs were anticipated, the PAH analyses provide low level analytical methodology in addition to standard SVOC analyses via USEPA Method 8270. Where field observations indicated low level analysis would be inappropriate, the laboratory was notified accordingly. Groundwater analyses performed in 2008 included TAL metals, cyanide, TCL VOCs, TCL SVOCs and PAHs. As approved by USEPA, groundwater samples were not analyzed for dioxins/furans or PCBs, based upon the results of the prior RI laboratory analyses.

2.5.4 Modifications to soil investigation

Placement of soil borings were advanced in locations as depicted in the SSP for 2006 sampling, and as depicted in the final SWP for 2008 sampling. All modifications to the soil investigation were discussed with EPA oversight personnel prior to implementation. Based upon field conditions, some modifications to the pre-approved locations and methodologies were required, as discussed in below.

2.5.4.1 2006 Deviations

Deviations from the soil investigation during the original remedial investigation were as follows:

- In areas where auger refusal was encountered, an offset boring was attempted within 10 feet of the original boring as described in the FSP. If refusal was encountered, alternate drilling technologies were considered as described below. Borings located in the northern portion of the north parcel, auger refusal was determined to be due to shallow bedrock, therefore alternate drilling technologies were not considered. Soil samples were collected based on the sample criteria described in the FSP if sufficient samples were collected. In areas where native materials were not encountered prior to refusal, representative samples were selected based on composition in addition to PID field screenings.
- Consistent auger refusal was encountered in Block E and Block G, due to the location and proximity to former structures which was evident in construction debris encountered in the soil cuttings generated from the HSA. Soil borings in areas of former structures (Block E, Block G, and AOC13) were advanced to the target depth using sonic drilling technology.

- Additionally, soil boring locations were relocated due to terrain and drill rig inaccessibility issues.

During the original remedial investigation, soil samples were collected as described in the FSP, with the following modifications:

- Soil samples were relocated based on the results of the geophysical investigation findings.
  AOC-2 Closed Landfill - Three soil borings were added in the following locations to characterize the waste in the landfill:
  AOC2SB13 - near southern edge of ~80 x 400 ft EM anomaly along western edge of landfill; consists of both negative EM-31 and anomalous magnetic gradient response.
  AOC2SB14 - within core of ~80 x 400 ft EM anomaly; an area of elevated EM in-phase response and slightly elevated EM ground conductivity response (>20 mS/m) versus background (<5 mS/m) bulk soil conductivity; anomalous magnetic gradient response throughout this area.
  AOC2SB15 - in area ~100 ft northeast of the ~80 x 400 ft EM anomaly; exhibiting buried metallic geophysical signature based on negative EM in-phase and anomalous magnetic gradient response.
  AOC 9 Approximate Location of Two Former Fuel Oil USTs - Four borings were installed in lieu of the two test pits as follows:
  AOC9SB1 - at peak EM-61 difference (>700 mV) and EM-31 in-phase (<15 ppt) response located at north end of survey area.
  AOC9SB2 - near "elbow" of linear-trending EM-31 ground conductivity anomaly ~10 ft northwest of the proposed Test Pit 1 CP location.
  AOC9SB3 - within linear EM-31 response that is directed east of the "Spray Pond" structure corner and ~25 ft south of the proposed Test Pit 2 CP location.
  AOC9SB4 - at predicted location of the more northerly of the two USTs and ~10 ft east of Test Pit 1 CP location. As discussed, there is no indication of buried metallic targets at the predicted UST locations for the geophysical instrument estimated depth of exploration (EM-61 to ~8 ft bgs & EM-31 to ~12 ft bgs).
  Block E Former Quenching Station - relocation of four and addition of one soil boring were conducted as follows:
  BESB4 was moved approximately 30 ft to south-southeast to intersect EM-31 ground conductivity "high" (>300 mS/m).
  BESB5 was moved approximately 20 ft to the northeast to intersect EM-31 linear-trending ground conductivity anomaly.
  BESB6 was moved approximately 30 ft to east to intersect EM-61 peak difference and EM-31 ground conductivity response within center of "tower".
  BESB7 was moved approximately 40 ft to north-northeast to intersect EM-31 ground conductivity "high" (>400 mS/m).
  BESB10 was added based on the peak EM-61 and EM-31 in-phase response located at south end of geophysical survey area and northwest of brick storage structure.
  AOC 8 Former Rail Car Thawing Area - relocation of three and addition of one soil boring were conducted as follows:
  AOC8SB2 was moved approximately 30 ft to the north to intersect anomalous EM-31 ground conductivity response located outside of predicted location of thaw pit.
  AOC8SB3 was moved approximately 20 ft to the northeast to intersect centerline of linear-trending EM-31/-61 anomaly that is interpreted to extend from the thaw pit area.

AOC8SB5 was moved approximately 15 ft to the east-northeast to intercept linear EM alignment (negative EM-31 in-phase response) that extends from the fuel oil tanks area.
AOC8SB14 was added based on what is interpreted to be a "T" intersection of linear-trending EM-31 alignments located ~25 ft northeast of AOC8SB13.
AOC-13 Former By-Products Area – the following soil borings were relocated as follows:
AOC13SB1 was moved approximately west 20 ft to avoid linear EM response that may be related to the natural gas line.
AOC13SB2 was moved approximately 20 ft to southwest to avoid linear EM response that may also be related to the natural gas line.

- The work plan initially called for the collection of discrete VOC encore samples every 2 feet in each boring. Samples with highest headspace readings were then submitted to the laboratory for VOC analysis. This sampling approach was modified such that encore samples were collected as proposed at the 0-2 ft interval and above the water table, but encore samples were only collected at intermediate samples with high PID readings or where field observations indicated potential contamination. Encore samples were not collected at intermediate soil samples that did not exhibit PID readings and/or field staining.
- Soil samples obtained from the sonic drill rig were collected from the 10 foot sampler barrel using plastic tube bags. Samples were taken from each distinct stratigraphic unit. Upon retrieval, the sample bag was opened and the sample field-screened with a PID. The soil core was inspected, described for gross composition, color, texture, relative degree of saturation, and other observable soil characteristics. A separate aliquot of each soil sample was field-screened with a PID utilizing standard headspace screening methods.
- Sediment samples collected for VOC analysis at GMRSD-16, GMRSD-17, GMRSD-18, and GMRSD-19 were compromised in transit to the lab due to a broken vial and the VOC data has been J-flagged. These samples were collected adjacent to The former COG pipeline crossing.
- During the installation of the shallow and intermediate monitoring wells, Shelby tube samples were attempted in the clay confining layers. The Shelby tubes collapsed and failed to obtain samples due to the cohesiveness of the clay. Shelby tubes were also attempted and failed within the sand aquifers of the intermediate wells due to the large cobbles and non-cohesive nature the sands. California samplers were used with the HSA to obtain 'intact' samples of the upper clay confining layer for the shallow monitoring wells. Bag samples were collected of the lower aquifer sands and clay due to the nature of sample collection with the sonic drill rig.

The excavation of the former gasoline UST area (AOC11) consisted of one cavity rather than two test pits as described in the SSP. Based on the locations of the geophysical anomalies, a cavity was deemed to be more adequate and conducive for exploratory purposes. Samples were collected based on the BUSTR Regulations and Section 2.0 of the BUSTR Technical Guidance Manual (dated July 2001).

2.5.4.2 2008 Deviations

During the 2008 Supplemental Investigation, deviations from the planned sampling activities documented in the 2008 Supplemental Work Plan (SWP) were as follows:

- Several of the soil borings required hydrated bentonite chip seal borehole grouting in place of a bentonite-cement grout slurry. This was due to the presence of very coarse granular subsurface fill materials (cinder fill). Attempts to grout with a slurry seal resulted in rapid loss of the liquid grout into the surrounding coarse fill.

- Several soil boring attempts were required at boring location MW-23S in AOC-9 and AOC20CA4SB3B in AOC-20 for successful completion of sampling and/or well installation at these locations. Drilling refusal was encountered at various depths at each location. Refusal appeared to be a result of subsurface encounter of blocky fill material such as concrete. At location MW-23S, additional boring attempts were necessary to install the resultant well (MW-23S) a lateral distance away from a subsurface product layer observed at an approximate depth of 23 feet bgs within initial boring attempts.

- Disposable bailers were required for sample collection from some of the new and existing wells. Bailer sampling was employed for 2008 sampling of wells MW-8S, MW-11S, MW-12S, MW-13S, MW-17M, MW-19S, MW-27M, MW-28S, and MW-29S. Remaining wells were sampled employing low-flow sampling methods.

- Installation of intermediate depth well MW-27M was completed as a result of the observed presence of potential free product at the water table interface within the adjacent planned shallow well boring (MW-27). MW-27M was indicated to be a potential well installation within the SWP based on the potential for encountering a NAPL. A decision was made to install the intermediate depth well based on visual observations of an apparent product material on drilling rods retrieved from the base of the boring prior to shallow well installation. Since the time of installation, no NAPL has been observed within either the shallow or intermediate depth wells at this location.

- Intermediate depth well installations (MW-17M and MW-27M) required the use of auger-drilling with grouted installation of steel casing to a field-determined depth, prior to continuation of drilling for placement of the intermediate depth well. Use of the steel casing was required to seal off overburden and shallow water-table depth materials as a protective measure for the intermediate well. Hollow-stem auger drilling methods were used for both drilling segments. Grout placement around the steel casing was allowed to stabilize/cure for approximately one week prior to restart of drilling.

- Sample locations within AOC 22 were located using portable GPS (Trimble Geo XT) equipment when the locations were pre-marked in the field in May 2008. Shortly after sampling was completed in May 2008, severe rains caused significant flooding of AOC 22. All sample location stakes were destroyed during the flooding, preventing surveying of the sample locations by a licensed surveyor. USEPA was notified, and approved use of the original GPS locational data for these sample locations. All other boring/well locations installed in 2008 were surveyed by a licensed surveyor.

- Soil borings in AOC 22 were advanced using a hand auger. Based upon the terrain and vegetative cover, equipment was required to be hand carried throughout the area to conduct sampling. The hand augered soils were placed in a stainless steel bowl, and following collection of VOC samples, were appropriately homogenized and remaining samples were collected. Based upon the field conditions that prevented use of motorized equipment to assist in movement of the sampling equipment and resultant soil cuttings, USEPA approved a request for residual soil resulting from the hand augered samples to be returned to the boring from which they were removed, along with decontamination water from each boring to be poured into each specific hand auger boring location. All soil cuttings, purge water and decontamination water from all other AOCs and Blocks were collected, containerized and disposed off-site under appropriate waste management and documentation procedures.

2.6 Groundwater investigations

2.6.1 Groundwater monitoring well network

The SSP originally called for the installation of shallow, intermediate, and deep groundwater monitoring wells. The shallow wells were located above the clay layer (if present) and typically intersected the groundwater table. Intermediate wells were located below the shallow wells, above the clay layer (if present) and if there was sufficient saturated thickness, or on a permeable groundwater zone beneath the shallow wells if the clay layer was not present. No deeper monitoring wells (set into the regional aquifer beneath the intermediate wells) were installed during the initial field investigation because the analytical results from the shallow and intermediate wells indicated vertical delineation within the aquifer was complete.

A groundwater monitoring well network and sampling program were implemented on both the northern and southern parcels of the Site to characterize groundwater quality that potentially may pose a risk to receptors and to determine whether there is any potential groundwater and/or ecological impact via contaminants migrating from and/or coming onto the Site. The hydrogeological investigation was based on information from the historical data review and analysis that identified an upper shallow groundwater zone and a deeper regional groundwater zone separated in part by clay bearing units. The investigation was also conducted to determine the location and extent of the presumed uppermost clay confining unit in areas where there is the potential for soil and groundwater contamination.

Twenty-one locations for monitoring well placement were identified to meet the primary objectives of the hydrogeologic investigation of determining the nature and extent of groundwater contamination at the Site and characterizing the Site geology/hydrogeologic setting for incorporation into the conceptual site model. In addition, well locations were identified to obtain up-gradient/background groundwater and aquifer data. A total of 32 additional monitoring wells were installed at the Site during the initial RI, subdivided according to their placement within each water bearing zone: shallow (denoted "S", well screen bisecting the water table), and intermediate (denoted "M", well screen at the bottom of the upper groundwater-bearing zone above the lower clay confining unit), or beneath the shallow well if no clay was present.

The three existing deep monitoring wells (MW-1D, MW-2D, MW-3D) are denoted with a "D", are also screened in the regional water bearing unit below the clay layer.

A total of 12 additional monitoring wells were installed at the Site during the supplemental RI, completed during the Summer of 2008. Supplemental RI monitoring wells were installed to primarily fill data gaps in various locations on the Site. The new wells include 10 shallow monitoring wells and two intermediate depth monitoring wells.

Southern parcel monitoring well network

Fourteen shallow and eight intermediate groundwater monitoring wells were installed during the initial RI within the southern parcel at the following locations:

- Three monitoring wells were installed in the south end of the southern parcel where existing deep wells MW-1D, MW-2D, and MW-3D are located. These well nests were supplemented with shallow monitoring wells, which were installed immediately adjacent to the deep wells.
  - **MW-1S** was installed at the southeastern corner of Block B;
  - **MW-2S** was installed at the southeastern corner of AOC 12; and,
  - **MW-3S** was installed at the northwestern corner of AOC 12.
- **MW-4S** and **MW-4M** were installed south of AOC 10 between the Hamilton North Well Field and the AK Steel southern property boundary.
- **MW-5S** was installed within AOC 20 between the former maintenance area and the Great Miami River.
- **MW-6S** and **MW-6M** were installed adjacent to west of the western boundary of the southern parcel, downgradient of the offsite location of the former Otto Coke Plant.
- **MW-7S and MW-7M** were installed adjacent to the east of AOC 13, between the former COG holder and the Great Miami River.
- **MW-8S** and **MW-8M** were installed to the east and downgradient of AOC 13, between the former by-products building / benzol yard and the Great Miami River.
- **MW-9S** and **MW-9M** were installed downgradient of AOC 8 (to the north of AOC 13 and adjacent to the Great Miami River).
- **MW-10S** and **MW-10M** were installed in the area between the New Miami Well Field and the AK Steel property boundary (across Augspurger Road from the northwest portion of the southern parcel).
- **MW-19S** was installed in the area along the eastern property boundary downgradient of AOC 12 in the former cooling tower area.
- **MW-20S** and **MW-20M** were installed to the east and downgradient of the former tar storage tanks within AOC 13.
- **MW-21S** and **MW-21M** were installed to the east and downgradient of the former benzol yard within AOC 13.
- **MW-22S** was installed downgradient of southern parcel offsite concerns (AOC16).

Ten shallow and one intermediate groundwater monitoring wells were installed during the 2008 supplemental RI within the southern parcel at the following locations:

- **MW-23S** was installed to assess groundwater within AOC-9. This well was positioned NNW of AOC9SB2 and WSW of AOC9SB1.
- **MW-24S** was installed to assess groundwater within AOC-9. This well was positioned SSE of AOC9SB3.
- **MW-25S** was installed to assess groundwater at the south end of AOC-13. This well was positioned WNW of AOC13SB14.
- **MW-26S** was installed to assess groundwater within Block D. This well was positioned NW of BDSB7.
- **MW-27S** and **MW-27M** were installed to assess groundwater at a west-central location in AOC-13. The wells were positioned NE of AOC13SB40.
- **MW-28S** was installed to assess groundwater at the north-eastern end of AOC-13. This well was positioned ESE of AOC13SB56, and along a line with MW-9S and MW-21S.
- **MW-29S** was installed to assess groundwater at the northern end of AOC-13. This well was positioned NNW of the AOC13SB12, SB13, and SB56 boring triangle.
- **MW-30S** was installed to assess groundwater within Block G. This well was positioned between BGSB11 and BGSB15.
- **MW-31S** was installed to assess groundwater at the northern end of AOC-13. This well was positioned S of AOC20SB39.
- **MW-32S** was installed to assess groundwater within AOC-20. This well was positioned between MW-5S and MW-7S, and E of AOC20CA13SB1.

Northern parcel monitoring well network

Four shallow and two intermediate groundwater monitoring wells were installed within the northern parcel at the following locations:

- **MW-11S** was installed within AOC 1 to the south-southwest of the closed landfill and north of Augspurger Road.
- **MW-12S** was installed within AOC 1 to the south-southeast of the closed landfill and north of Augspurger Road.
- **MW-13S** and **MW-13M** were installed within Block A to the north-northwest of the closed landfill.
- **MW-14S** and **MW-14M** were installed within AOC 21 in the northern-most portion of the northern parcel to be used for background purposes.

Closed landfill monitoring well network

Four shallow groundwater monitoring wells (**MW-15S**, **MW-16S**, **MW-17S**, and **MW-18S**) were installed around the closed landfill during the initial RI. The four wells were placed around the perimeter of the closed landfill to determine the nature and extent of groundwater quality surrounding the closed landfill. The length of the screened interval was determined based on depth to water (if any), subsurface geology (e.g., the presence of a clay layer) and the depth of any waste observed. One intermediate groundwater monitoring well (**MW-17M**) was installed adjacent to MW-17S during the 2008 Supplemental RI to determine intermediate depth groundwater quality downgradient of the closed landfill.

2.6.2 Monitoring well installation

All shallow monitoring wells were installed using hollow-stem auger (HSA) drilling techniques. Intermediate wells were installed using both HSA and sonic drilling techniques. The shallow wells were installed with the screen bisecting the water table within the upper water-bearing unit; the intermediate wells were installed within the upper water-bearing unit (average total depth of 30 - 40 feet bgs) with the screen located at the top of the clay confining unit; or beneath the shallow wells if the clay was not present in a permeable groundwater unit. Dual casing installation methods were utilized for the intermediate monitoring wells to allow the upper water-bearing zone to be effectively "sealed off" while the monitoring well assembly was installed in the lower water-bearing unit. All monitoring wells were equipped with a monitoring well assembly consisting of 2-inch I.D. PVC screen and casing inserted through the inner bore of the HSA augers (shallow wells) or through the drill sleeve within the outer casing assembly (intermediate wells). The screened section within each well was either 10 or 5 feet in length.

All monitoring wells were completed with a steel protective casing extending at least two feet above the ground surface with a locking cover. In locations where the wells need to be protected from traffic damage, the wells were surrounded by a minimum of three bollards extending at least four feet above the ground surface, and set into a concrete pad. Each well was labeled with its unique well identification number.

During the initial RI, the twenty-two shallow groundwater monitoring wells were installed from November 15 through December 8, 2005, and the ten intermediate groundwater monitoring wells were installed from February 22 through March 21, 2006. During the supplemental RI, the ten shallow and two intermediate monitoring wells were installed from May 28 through July 1, 2008.

All monitoring wells were developed to remove fine-textured sediments (i.e., silts, clays, and fine sand) introduced to the well screen and adjacent gravel pack during the installation process. Well development began no sooner than 24 hours after completion of the monitoring wells to allow sufficient time for the grout and cement to properly cure.

Boring logs, monitoring well construction forms, and well development forms for all monitoring wells are included in Appendix A. Completed Field Sampling Forms for the hand augered locations within AOC 22 are also included in Appendix A.

2.6.3 Groundwater elevation monitoring

Groundwater elevations were obtained from the established monitoring well network prior to each groundwater sampling event. In addition to obtaining groundwater level data at the time of sampling, groundwater levels were recorded from all Site monitoring wells on a monthly basis throughout the initial RI phase, and one set of groundwater elevations were obtained during the Supplemental RI. Water levels were measured using procedures detailed in SOP 101 in Appendix A of the FSP. Depths to water were measured to the nearest 0.01 foot using an electronic water level probe. The latest groundwater elevation information is summarized in Table 3.7-1.

For wells that were sampled, the well was also checked for the presence of non-aqueous phase liquids using an electronic interface probe (i.e., light NAPLs and dense NAPLs). No NAPLs were detected or observed during any site groundwater monitoring well sampling or water level check event, including the most recent well check event completed on September 30, 2008, using an interface probe in select wells.

2.6.4 Hydraulic conductivity testing

In April 2006, falling and rising head slug tests were performed at fourteen shallow wells, seven intermediate wells, and two deep wells to determine the hydraulic conductivity of the saturated deposits at the Site. At each location, the static water level was measured and recorded prior to beginning the tests. An InSitu PXD-261 pressure transducer was then placed in the well at a depth of approximately ten feet below the measured water level or at the bottom of the well, depending on the height of the water column. The transducer was connected to an InSitu Hermit 3000 data logger to track changes in water level. A thin sand-filled tube, with a 1.34-inch diameter and length of 59 or 72 inches (the "slug"), was lowered quickly into the well. The water level within the well increased following insertion of the slug, and changes in water level were recorded and logged at specified time intervals as the water level re-equilibrated. Measurements were recorded until the water level recovered to at least 90% of static conditions. A rising head ("slug out") test was then initiated by quickly removing the slug from the well and logging the changes in water level as the water re-equilibrated. The data from all slug tests for each well were then input into AQTESOLVE®, a computer software program that estimates the hydraulic conductivity.

2.6.5 Groundwater sampling

All groundwater sampling activities were conducted in accordance with the site-specific Health and Safety Plan (HASP) to protect the field personnel during sampling and on-site activities and in accordance with the project Quality Assurance Project Plan (QAPP) and Field Sampling Plan.

At the beginning of each day, all field instrumentation (YSI multi-parameter water quality monitor and/or LaMotte turbidity meter) were calibrated in accordance with the QAPP. The meters were also compared to commercially available standards at the conclusion of each day of sampling. Calibration information was recorded on a calibration log form. Preliminary field notes that were taken upon arrival at each well included the well number, well conditions, and the conditions of surrounding area. The depth to water and saturated interval in each well was obtained using an electronic water lever meter. The groundwater sampling equipment was then set up for low-flow collection of groundwater.

Sample collection involved using a variable flow pump to purge stagnant water from wells at a low rate of groundwater withdrawal ranging from approximately 100mL/min to 300mL/min. Temperature, pH, dissolved oxygen (DO), specific conductivity, turbidity and oxidation-reduction potential (ORP) were measured during purging of the well to indicate stabilization of the water prior to sampling. The field parameters were measured using a YSI with flow-through cell, and measurements were recorded in the field notebook to monitor the stabilization of all parameters. Readings were taken and recorded every 5 minutes or every well volume until all field parameters had stabilized, which then allowed for the collection of the groundwater sample in laboratory-supplied containers.

Groundwater samples at all monitoring wells were analyzed for TAL metals (total), TCL VOCs, TCL SVOCs, PAHs (SW 846 Method 8310), and PCBs. Samples from thirty percent of the wells were analyzed for dioxins and furans. Dioxins and furans were not included in the scope of the 2008 Supplemental RI groundwater sampling and analysis.

If turbidity greater than 5 NTUs was measured at a well during sampling, an additional sample was collected, field filtered (using disposable filters and disposable plastic tubing), and analyzed for dissolved metals.

Non-dedicated sampling equipment (water level meter, groundwater pump, YSI) was decontaminated between sample collection points in accordance with SOP 7600 in Appendix A of the FSP.

All shallow groundwater monitoring wells were sampled from December 5, 2005 through December 16, 2005. Groundwater was not collected from MW-13S, which did not produce sufficient groundwater for low-flow sampling purposes. Field filtering for metals was done in addition to collecting an unfiltered metals sample for wells MW-3S, MW-4S, MW-8S, MW-12S and SMW-15, because the turbidity of the groundwater would not drop below 5 NTU. The sample collected for filtered metals from MW-4S was obtained after the low-flow sampling had been completed, using a single-use (dedicated) bailer.

Intermediate groundwater monitoring wells were sampled from March 31, 2006 through April 13, 2006. A grab sample was collected from MW-13S between April 3 through 14, 2006 using a single-use dedicated bailer.

Water samples were collected from temporary monitoring wells installed at AOC2SB13 and AOC2SB15, and from the open borehole of AOC2SB14 on January 24, 2006. These samples were collected to evaluate leachate at the bottom of the closed landfill. Samples were collected using a single-use dedicated bailer for each location.

Temperature, pH, DO, specific conductivity, and turbidity were measured prior to sampling using a HORIBA U-22 multi-parameter water quality monitor. The HORIBA was decontaminated between sample collection points in accordance with SOP 7600 in Appendix A of the FSP.

Supplemental RI groundwater sampling was conducted between June 11 and July 8, 2008. It should be noted that during completion of the Supplemental RI groundwater sampling event, several monitoring wells were required to be hand-bailed for the purging and sample collection process primarily due to an insufficient water column thickness available at the time of sampling. Disposable bailers were required for sample collection from wells MW-8S, MW-11S, MW-12S, MW-13S, MW-17M, MW-19S, MW-27M, MW-28S, and MW-29S. Remaining wells were sampled using low-flow sampling methods.

All investigation derived waste from installation of hollow stem auger and sonic drilling, well development and purge water, and decontamination water were properly containerized in 55 gallon drums and stored on-site in a designated investigation derived waste management area within the fenced and locked southern parcel. Decontamination of drilling equipment was conducted within a properly constructed decontamination pad to capture decontamination water generated as a result of cleaning drilling equipment. All investigation derived waste was properly characterized, profiled, transported and disposed off site by Heritage Environmental under appropriate manifest/documentation. All investigation derived wastes were removed from the site by the end of September 2008.

2.7 Human population surveys

The 2000 US Census Bureau data was used to assess the distribution of population within 800 feet of the Site boundary and 200 feet of the former COG pipeline starting from the site. The estimated population is conservative as the population of entire blocks, which fell partially within the designated area, have been used. Tables 2.7.1 and 2.7.2 show the population distribution categorized by blocks.

The total number of people living around the site is 663. Of these about 236 live in the area just north west of the site which is incorporated in New Miami, Ohio. Another 274 are located in the area adjacent to the east boundary of the Site in the Northern Parcel. The residential area near the northern tip of the property houses about 95 people. The three above mentioned areas together account for about 90% of the people living around the site. The remaining portions of the population are distributed around the property in smaller pockets.

The total number of people living within 200 feet of the pipeline is estimated to be about 995. This population is divided between St Claire Township, Trenton and Middletown. About 151 people live around the section in St Claire Township, from where the pipeline starts. The pipeline then enters the City of Trenton. This section houses about 470 people accounting for just less than 50% of the people living around the entire length of the pipeline. About 374 people live in the Middletown section of the pipeline, where the pipeline ends.

2.8 Ecological investigations

The Site contains a riparian area, designated as AOC 22. No wetlands are present on the Site, nor are any threatened or endangered species of concern for the Site. As described earlier, the Great Miami River bounds the site to the east.

A Screening Level Ecological Risk Assessment was conducted for the site, with the final version of the document submitted to US EPA and Ohio EPA for approval in March 2008 (ENSR, 2008).

USEPA approved the SLERA, and based upon requests from Ohio EPA and US EPA, KEMRON prepared a Risk Assessment Assumptions Document (RAAD) for review and approval prior to moving forward with conduct of the Baseline Ecological Risk Assessment (BERA). The RAAD was revised in response to OEPA comments, and after discussions with USEPA and OEPA, it was determined that, while formal approval of the RAAD would not be received, the RAAD provided sufficient information that the Agencies would allow preparation of the BERA without a final RAAD. The approval to move forward with BERA preparation absent a final, approved RAAD was based upon agreement that OEPA guidance for conduct of ecological risk assessment would be followed, and that the data from the 2008 Supplemental RI work, especially data from AOC 22, would be fully incorporated within the BERA.

Additional information regarding the SLERA, RAAD and BERA is provided in Section 7.0 of this RI Report.

2.9 Potable water well survey

A potable well survey was conducted and encompassed an area of 800 meters from the Site boundary. The purpose of the survey was to identify all existing potable wells, including the New Miami well field and City of Hamilton North well field. The findings of the survey (well logs) are included in Appendix B. A map showing the location of the wells is also included in Appendix B.

2.10 Background Sampling

Background soil samples were collected during the initial RI from off-site and on site areas and analyzed for TAL metals, dioxins/furans and PAHs. The background analytical results were compared to the applicable remedial investigation sample results and were used to assist in evaluation of site conditions. A discussion of the background sampling program and analytical results is presented in Section 4.28. On site monitoring wells MW-6S, MW-10S and MW-14S, installed during the remedial investigation, are representative of upgradient groundwater conditions based on groundwater elevation data. The analytical results from these wells were used to assist in evaluation of site groundwater conditions. A discussion of the upgradient and site groundwater conditions is presented in Section 4.29. USEPA approved the background data set as being sufficient for the Site as part of its approval of the final SWP. Therefore, no additional background samples were required for inclusion in the 2008 Supplemental SI field work.

3.0 Physical Characteristics of the Study Area

3.1 Surface features

The southern parcel is currently vacant and is surrounded by a chain link fence which remains locked. A roadway through the property remains and a large hilly area exists on the western side of the site where the blast furnaces were formerly located. Some concrete slabs remain, indicating where some of the buildings and a large gas collector were once located. The majority of this parcel is covered with tall grasses and occasional trees. The entire southern parcel is fenced and gates remain locked.

The northern parcel is also currently vacant. No buildings are present, except for remnants of the former slag processing plant. Gravel roads are present in the northern parcel along with a CSX rail line that bisects the property. The majority of the northern parcel is also covered with grasses and occasional trees, especially toward the property boundaries. The closed landfill is fenced and the gates remain locked.

3.2 Meteorology

Data for the analysis of meteorological conditions at the Site were obtained from the National Climactic Data Center, U.S. Department of Commerce. Daily maximum, minimum and average temperatures, precipitation, and resultant wind speed have been summarized in Table 3.2.1. The available data were collected between June 1997 and December 2005 at the Butler County Regional Airport, Hamilton in Butler County, Ohio at an elevation of 634 feet above mean sea level.

The total monthly precipitation has varied between 0.41 to 6.77 inches from 1998 to 2006. The wettest months were April, May, June and July, receiving an average of 4.11, 4.64, 3.9 and 3.91 inches of rainfall, respectively. February and March have been relatively dry with an average total precipitation of 1.73 and 2.5 inches, respectively. The average precipitation during the rest of the year has varied between 2.64 and 2.94 inches per month. The total annual precipitation varied between 23.85 inches (1999) and 45.68 inches (2002) in the past 8 years. The average annual precipitation during this period has been 38.41 inches.

Average daily temperature varied between 0°F and 90°F. December, January and February have been the coldest months with minimum average temperatures of 15.2°F, 8.9°F and 21.1°F, respectively. The relatively warm months have been June, July, August and September with maximum average temperatures of 80.8°F, 83.9°F, 82°F and 77.44°F respectively. The maximum temperature recorded in the past 9 years was 104°F and the minimum -19°F.

3.3 GMR Surface water hydrology

Stream gauging data for the Greater Miami River was obtained from National Water Quality Assessment Data Warehouse, Unites States Geological Survey for gauging stations in Hamilton and Middletown. The Middletown station is located upstream of the Site whereas the Hamilton stream gauging station, which was installed in 1927, is located downstream of the Site. Data collection at the Middletown station began in July 1994. The tables below summarize the stream gauging data recorded at the Hamilton and Middletown gauging stations.

Hamilton gauging data summary

Month	Maximum Discharge (cfs) (year)	Minimum Discharge (cfs) (year)	Average Discharge (cfs)
January	73,900 (1959)	258 (1945)	5,200
February	58,100 (1929)	274 (1945)	5,183
March	57,200 (1963)	389 (1964)	6,029
April	50,700 (1996)	638 (1941)	5,872
May	57,400 (1933)	380 (1934)	4,360
June	45,100 (1958)	284 (1934)	3,303
July	35,200 (2003)	205 (1934)	2,281
August	32,200 (1995)	170 (1934)	1,408
September	30,100 (2003)	155 (1941)	1,062
October	27,600 (1986)	204 (1941)	1,132
November	31,800 (1985)	192 (1934)	1,991
December	48,700 (1990)	241 (1934)	3,343

Middletown gauging data summary

Month	Maximum Discharge (cfs) (year)	Minimum Discharge (cfs) (year)	Average Discharge (cfs)
January	53900 (2005)	404 (2000)	6152
February	20900 (2005)	450 (2000)	4177
March	20500 (1997)	1030 (2000)	4969
April	36900 (1996)	983 (1995)	5498
May	31900 (2002)	985 (1999)	5835
June	33500 (1997)	684 (1999)	4613
July	38000 (2003)	546 (2000)	2548
August	29300 (1995)	226 (1999)	1644
September	30400 (2003)	220 (1999)	1462
October	26300 (2001)	250 (1999)	1570
November	25400 (2003)	290 (1999)	1784
December	33000 (2001)	345 (1999)	3394

3.4 Regional geology

Unconsolidated deposits of southwestern Ohio consist of silt and sand and gravel with lenses of clay and till. The clay and till lenses may be significant in size, locally identified as discontinuous confining layers. Well drillers have identified the clay and till lenses as having a blue color with gravel inclusions. These unconsolidated deposits found around the Great Miami River in Butler County are identified as the Southern Ohio Loamy Till Plain in the physiograhic region of the Central Lowland Till Plains (Brockman, 1998). The Southern Ohio Loamy Till Plain is described as loamy till of end and recessional moraines, commonly found in deep stream-cut valleys between flat lying ground moraines. The unconsolidated deposits can be non-existent at the river's edge and encountered up to approximately 300 feet below ground surface throughout the rest of Butler County (Lloyd and Lyke, 1995; Ohio Geological Survey 2003 and 2004).

The Wisconsinan glacial till and outwash deposits of southwestern Ohio overly Lower Paleozoic carbonate rocks interbedded with shale (Ohio Geological Survey 2001, 2002 and 2003). The primary units of the Lower Cambrian-Ordovician bedrock in southwestern Ohio are the Eau Claire Formation, the Knox Dolomite and the Black River Group (Hull et.al., 2004). Beneath the Site, underlying the unconsolidated deposits, lies the Kope Formation (Swinford and Vorbau, 1998), an upper Ordovician shale and limestone unit, which consists mostly of shale (approximately 95 percent) and minor interbedded layers of limestone (Shaver et.al., 1986). The Kope Formation is typically found between the Point Pleasant (below) and Fairview (above) Formations (Hull et.al., 2004) and is rich with fossils.

3.4.1 Geomorphology

The bedrock surface in southwestern Ohio was shaped by water erosion during glaciation. As such, the thickness and surface relief of the unconsolidated material deposited by glacial movement varies greatly across southwestern Ohio. Glacial sediment deposited along the stationary ice front formed ridge moraines, characterized by thick, draping linear drift deposits (Ohio Geological Survey, 2004). These patterns observed in western Ohio define the glacial ice lobes of the Wisconsinan ice sheet. As the glacial front retreated and advanced (at least three known stages), coarse sand and gravel and till were deposited in the deeply carved valleys of the bedrock. As the stagnant glacial coverage melted, melt water deposited finer material (clay and till) over the sand and gravel (Lloyd and Lyke, 1995), creating the relatively low relief surface over much of the western and northern portions of Ohio; as compared to the high topographic relief observed in the unglaciated southeastern portion of state.

Early Pleistocene glaciation also slightly altered the course of the Great Miami River, identified as a tributary of the pre-glaciation Teays River (Debrewer et.al., 2000). As the glacier retreated, melt water infiltrated the river, increasing flow rate and depth, resulting in large stream-cut valleys in the bedrock upon which sand and gravel and till was deposited (Ohio Geological Survey, 2004). The Great Miami River's (also formerly known as the Old Kentucky River during pre-glacial times) flow path was altered as the glacial front advanced over its pre-glacial course (Debrewer et.al., 2000). As the glacier continued its retreating and advancing stages, the former river bed was filled in with coarse sand and gravel and till deposits (Lloyd and Lyke, 1995). These filled in river courses located adjacent to the Great Miami River are the primary water source (aquifer) along the river valley.

3.4.2 Site geology

The geology observed on Site is representative of the regional glacial outwash geology, and has been disturbed by excavation activities. Boring logs for the Site providing a detailed view of the geology at each of the borings are presented in Appendix A. The results of the Shelby tube analysis (Geotechnical results) is contained in Appendix C. The report also includes a table summarizing the results. Cross sections through various parts of the site as seen on Figure 3.4.2-1, are presented as Figures 3.4.2-2, -3, -4, and -5, and present a more generalized view of site geology and of the connectivity of the various geologic units encountered. Cross section A-A' spans the length of the southern parcel from south to north along the river, B-B', C-C', and D-D' provide cross sections perpendicular to the river. On the northern parcel, E-E' provides a cross section of the length of the site, F-F' provides a cross section perpendicular to the river, and G-G' provides a cross section perpendicular to the river and through the closed landfill.

Fill is found throughout the majority of the site as seen in each of the cross sections. It consists of a mixture of sands, clays, silts, and gravels, along with slag material, brick, and concrete in places. The fill ranges in thickness between 0 and approximately 30 feet. Slag was noted at depths up to 30 feet, and concrete was noted at depths of up to 22 feet at some locations.

The native lithology consists of sand and gravel layers deposited as glacial outwash with discontinuous silty clay layers. The sand and gravel unit varies in content, and is generally poorly sorted and unconsolidated, with occurrences of silt or clay. Lenses of sand and silty clay can be found throughout the site. A significant clay-silty clay layer has been identified across the site between approximately 595 and 540 feet MSL within the sand and gravel unit. This large, locally confining, lens ranges in thickness from approximately 10 feet up to approximately 50 feet (Figures 3.4.2-2 and 3.4.2-4). Content of silt and clay varies throughout the site, and additional clay and silty clay lenses often contain some gravel and trace sand.

When Site geologic data are correlated with geologic information from south of the site at the Hamilton North Well Field (Figure 3.4.2-2), it is inferred that the largest of the clay layers extends under the Great Miami River into the subsurface of the City of Hamilton's North Well Field. This clay layer is indicated as a significant aquitard to inhibit migration of potential contaminants from the Site to the south. Additional discussion of the geologic conceptual model for groundwater fate and transport is included in Section 5 of this RI Report.

On the southern end of the Southern Parcel, snail shells were noted in sand and silt layers in the vicinity of AOC 20 in composite areas 1, 4, and 5 and in Block C as shown in B-B' on Figure 3.4.2-3. The layers containing these shells appear to start just below fill at an elevation of approximately 583 to 591 feet MSL. These layers indicate the existence of a former low energy water body, likely a small channel related to movement of the Great Miami River over time.

3.4.3 Site surface soils

Surface soils on site consist primarily of medium to dark brown silty clay that contains trace amounts to some gravel. Surface soils on site are largely composed of fill materials including slag, creating variability of surface soils throughout the site. Variations consist primarily of silt, clay, or silty sand, also containing trace to some amounts of gravel. Block A surface soils consisted primarily of slag.